THE Petroleum Engineer

COMBINED EDITION

• Drilling and Producing • Refining and Gas Processing • Oil and Gas Pipelining

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Why Naval Petroleum Reserves?

IT would be hard to find a federal project that has failed more completely than the Naval Petroleum Reserves. Its purpose — "to hold intact and in perpetuity an amount of oil calculated to meet any fuel emergency in the future" — is, of course, impossible for the agency to fulfill.

The idea sounded all right in 1906 when the Congress authorized four new battleships built to use fuel oil instead of coal. U. S. geologists estimated the nation's oil supply would not last as long as the battleships so the system of reserving promising oil lands for the Navy was launched in 1910.

The erroneous calculation that led to the establishment of the Naval Petroleum Reserves was understandable a half century ago. But today, when President Truman created another Naval Petroleum Reserve out of the Continental Shelf so that the oil deposits "be conserved and utilized for the national security," the act is incomprehensible from a national security standpoint.

As far back as 1924 Admiral Robison said the only oil the Navy could call on in emergency was that immediately available. Oil in Naval Petroleum Reserves, in his opinion, would not be a factor in an emergency of hostilities though it might help us pay tribute imposed by some conqueror as a result of a war in which we had been unsuccessful because of want of preparedness in the matter of fuel oil.

In two world wars we have learned that the oil used in emergencies is not from deposits preserved underground but from the active fields operated by individual oil companies.

In World War II production from the Naval Petroleum Reserves never reached its peak until 1945, the last year of the war, and then was only a small part of the amount required by the Armed Forces. It was so costly in terms of trained personnel, including Naval officers, and in scarce equipment that it had the dubious distinction of being labelled the most expensive oil in the nation.

In the six years 1945-1950 inclusive, the Congress appropriated $68,762,000 for operation of the Reserves in California, Wyoming, and Alaska. Income from the Reserves during the same period was $31,885,285.

This deficit operation is certainly not the fault of the Navy. Geologists recommended exploration in Alaska in 1923. Money for the project was not appropriated by Congress until 1945. It is the slow motion control by government that smothers initiative in such an enterprise.

If oil companies had gone into Alaska as they were preparing to when the reserve was set aside we could easily have had production there in the last war and the costly and ineffectual Canol Oil project would have been unnecessary.

No body knows better than the Navy the difficulties of directing a project within the narrow confines between the federal government on one side and the oil companies, which actually carry on operations, on the other. In 1948 the Navy made an attempt to give the Teapot Dome reserve to the Department of Interior but the Congress, perhaps sensitive to seeing that name again in headlines, refused.

A petroleum reserve in the Continental Shelf, "husbanding petroleum underground for future military use" is more impractical, if possible, than reserve areas inland. Drilling barges in the Gulf have dodged typhoons with some success but could they stand off submarine attacks of an enemy power while seeking oil deposits? It would take a large part of the fleet to protect Gulf operations.

As we have learned in the years since 1906 the idea of the Naval Petroleum Reserves is based on two fallacies, both of which are still used as sound argument in some political circles.

The first one is that we are running out of oil. Even the conservative U. S. Geological Survey has given up this one. It reported that until economic incentives to the U. S. oil and gas industry failed, our supplies are virtually limitless. We have not only greater reserves each year of liquid petroleum but there are vast untouched deposits of shale oil, and coal synthesis offers another source of liquid fuel.

It is true we are importing a million barrels of oil a day, as President Truman pointed out. But he failed to mention that we also export a quarter of a million barrels of petroleum products daily and have a million barrels a day potential production in this country that is held back at the request of the Defense Administration. The stockpiling of this defense material, it may be added, is not paid for by the taxpayers.

With the present development of new sources of energy we are more likely to run out of demand for hydrocarbon fuel than we are to run out of supply.

The other fallacy — that of conserving oil deposits underground — recalls the Biblical parable of the buried talent. Our oil reserves, like the servants' talents, are increased by use. It sounds like a paradox but it has been proved true. Through the knowledge gained by production of oil and the technological advances that result, the amount recovered from a field can be doubled and trebled. During World War II we supplied Russia, which has greater oil potential than we have, with oil products. Unlike the common conception, an oil reservoir usually takes long years to find, long years to develop, and they continue production for longer years. Often, after one life, an oil field is given another by a new recovery method or by the discovery of a reservoir below the first one, which could only be reached because equipment for deeper drilling was built.

Obviously, you can't find better methods of developing a structure and invent equipment required for its development by preserving oil underground. That, as the oil industry has found, is paying tribute to ignorance.

So why expand failure by expanding the Naval Petroleum Reserves? We would save money and make money by selling those we now have. Why pretend the Navy can provide fuel more cheaply by operating its own oil fields when it invariably costs more? Why set up a new underwater breeding ground for future political scandal? Why force men specialized in Navy operation to become amateur oil operators in one of the most highly technical industries in the world?

So far as oil supplies are concerned we will have less instead of more. So far as cost is concerned, the system has proved uneconomic; it will cost more, not less. So far as national security is concerned, it is no more dependent upon setting aside petroleum reserves for fueling the Navy than it is dependent upon setting aside agricultural lands to feed Navy personnel.

Our national security and our national progress is now, as it has ever been, based on development of our natural resources by a dynamic and inventive U. S. industry and agriculture, under the only successful economic system ever devised—free competitive enterprise.—E.A.

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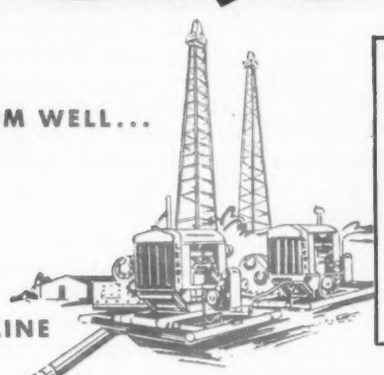

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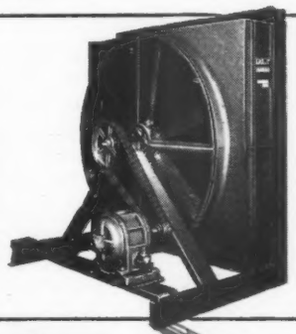

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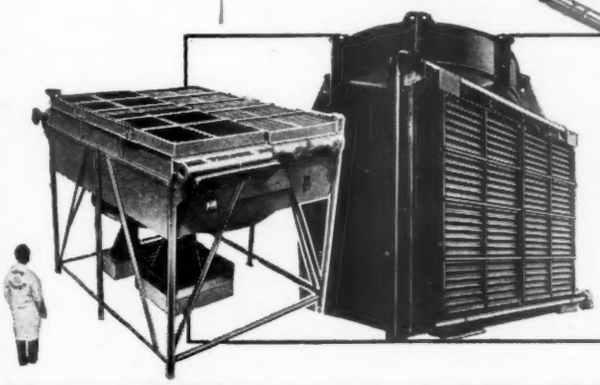

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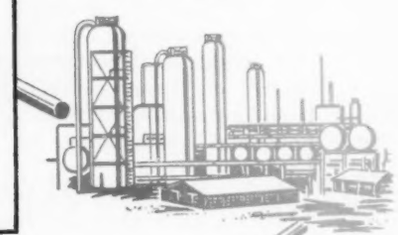

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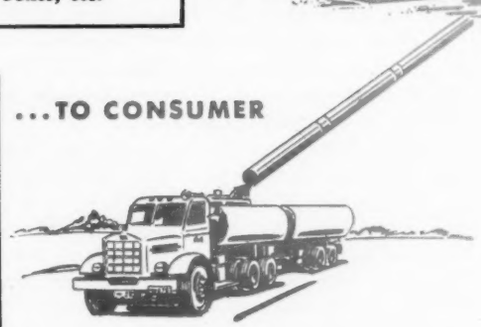

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With the EDITORS.....

Trans Mountain's Training Program

Trans Mountain Oil Pipe Line Company, which plans to have its 718-mile crude oil system between Edmonton and Vancouver completed by the end of August, is going about the training of its key operating personnel in a common sense manner. Because of advanced skills in such matters, resulting from the earlier development of the industry in the United States, Americans were called upon to lend their knowledge to the construction of this pipe line system. Canadian subjects, however, will take over its operation upon completion, which is as it should be.

The men who will operate Trans Mountain are being sent to the United States in groups, eight to a group, to study methods employed in this country. After a study course of approximately three months they return to Canada to continue their studies by considering the problems that actually will confront them on Trans Mountain. Two groups are in the United States at the present time; one group already has been here and returned to Canada. Leaders of these study groups are highly trained men who have made outstanding contributions to the American pipe line industry.—F. H. L.

Automation — When?

This new, coined word is on the tongues of an increasing number of refining, chemical and other industrial executives, junior executives and engineers in the immediate past and the present.

Not yet reduced to a Websterian definition of exact terminology, the word is taken now to mean our present concept of completely automatic control and operation of processes. It connotes non-human control of the processing of crude, for example, from its desalting all the way through to the separation and purification of finished, commercial products.

The question arises, can actual automation be attained in the foreseeable future. If so how, and at what cost? Automatic control began a couple of decades ago and more, one of the most outstanding examples being control of temperature by means of a controller-recorder mechanism. Such a mechanism has achieved its result by, for instance, a diaphragm valve operation arrangement by which an indicator unit actuated by a temperature change—thermostat for illustration—puts into motion in turn a valve controlling feed of fuel to a burner, or some other factor that can change the temperature picture to suit prearranged plans. Gradually other developments have followed, until much of our present-day plant operation is automatic to a degree.

With the introduction of mass spectometers and similar units in infrared, and X-ray, electronics calculators that can reduce computation time from weeks to minutes or seconds, magnificent strides have been made. The mass spectometer has progressed in six-seven years from a purely analytical instrument, cantankerous and temperamental, to an adjunct to direct semi-automatic control.

Full automation visualizes an operation wherein the taking and analysis of control samples, as well as temperature, pressure, and flow controls will be automatic and continuously recurrent when required, when no human operator need be in attendance from day's end to day's end to turn out products of specified properties. Management, only recently becoming actively aware of the possibilities of these trends, wishes to know, instantly, the cost of these developments, and when they will be upon us.

Innumerable factors must be known and controllable before automation can become an accomplished fact. The influence of all factors on the operation and the products must be discovered and evaluated; means must be worked out to interpret these factors into terms of control actuations, and correction of factors that are "out of line" with operational schedules must be developed without the time-lag inseparable from correctional operations nowadays.

Opinions as to the time when automation will be with us in full vary from a guestimate of five years, to a large and prominent interrogation point. Oil refining has progressed probably farther than any other industry. One executive (Chem. Wk., 12-27-52) sees automation in five years, 20 per cent added to plant cost thereby. D. P. Campbell, M.I.T. engineering professor, thinks it at least ten years away, says we are "working on an ignorance frontier" where five-six years are required to develop the necessary equations, even using computers. Our present estimated cost for conventional instruments of 5-7 per cent of plant costs may be doubled to give "98-99 per cent automation" Campbell thinks now. The lost small increment to give complete automation may be extremely expensive, more than the returns.—ALF.

PAD on Gas Pipe Line Needs

Those who are of the opinion that a sharp letdown in gas pipe line construction is about to take place would do well to consider a recent report by the Petroleum Administration for Defense. The report was made public by Secretary of the Interior Oscar L. Chapman shortly before relinquishing that office. The natural gas industry, said the statement, will have to carry on a continuing program of new pipe line construction to meet expected peak day demands if all potential customers are to be given service through 1955.

Although no pinch is anticipated for this winter, it is expected that demand by the winter of 1955-56 will be 38 billion cubic feet a day, or approximately 50 per cent greater than 1951-52 peak day requirements of 25.3 billion cubic feet. An additional daily supply of about 1 billion cubic feet will be required in the winter of 1953-54, 1.7 billion cubic feet in 1954-55, and almost 3 billion cubic feet in 1955-56. Expansion plans already have been made to take care of much of this increase, but more will need to be done. Unless sufficient pipe line capacity is provided, as well as an increase in underground storage and other peak-shaving devices, the growth of markets in some areas will have to be controlled, it is pointed out by Deputy Petroleum Administrator J. Ed Warren.

The PAD study shows that if all potential demands are to be supplied, it will be necessary to lay about 10,000,000 tons of pipe from 1952 through 1955. This is a large order unquestionably, and if accomplished will exceed the years of 1950 and 1951 when activity was at a maximum. In 1950 the industry laid 1,723,000 tons of large lines, and in 1951, 1,728,000 tons—F. H. L.

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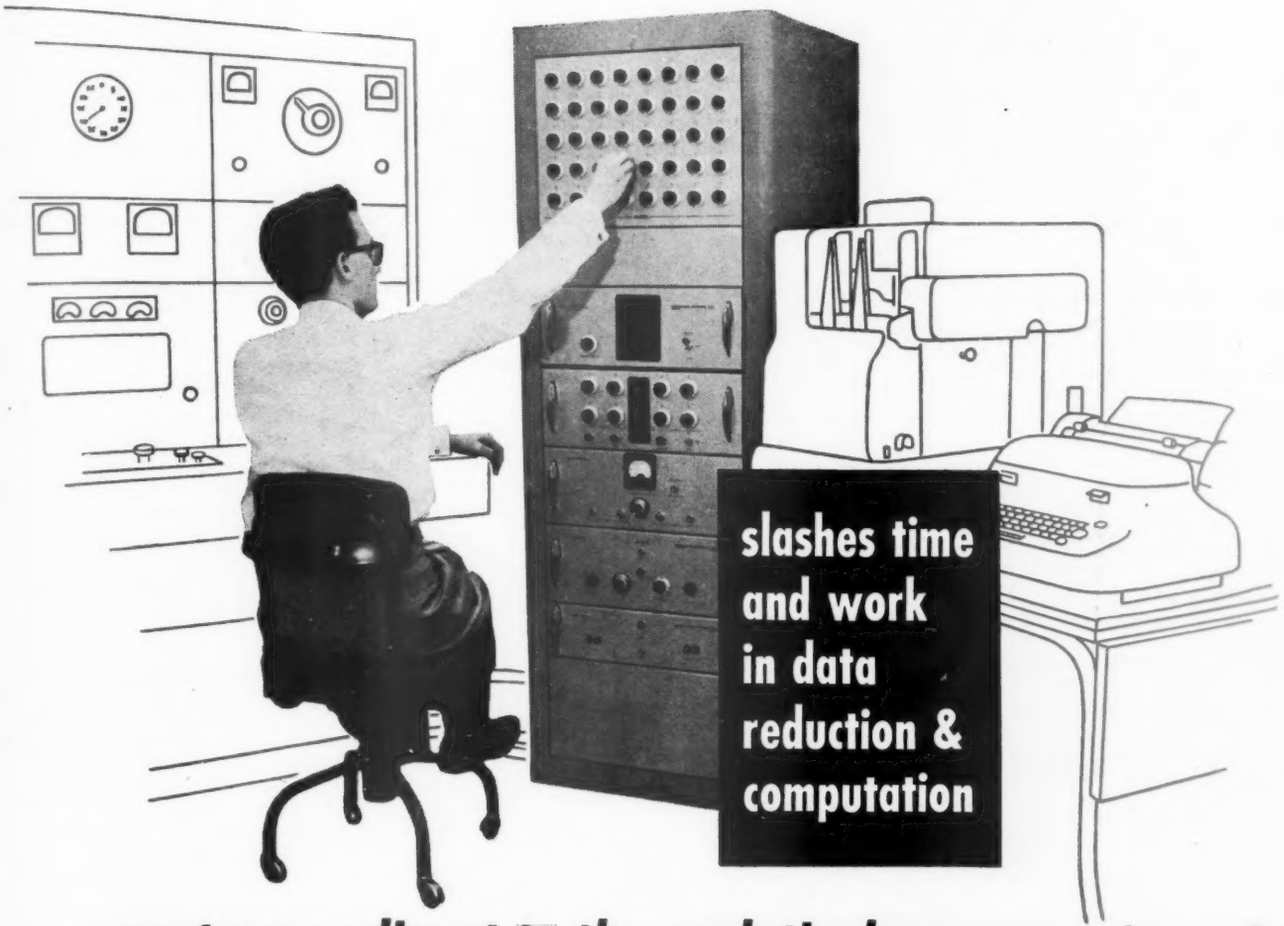

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HIGHLIGHTS IN OILDOM

Kirkuk to Europe Line

Now under consideration is a pipe line running from the Persian Gulf oil fields to Europe. The line would carry the billions of cubic feet of gas now being flared off in the oil fields for lack of convenient markets. Bechtel Corporation made an economic study of this line in 1951, and is further continuing its studies. Its president, S. D. Bechtel, has stated that the pipe line system will be built when the peoples of Europe want the fuel enough.

Crude Oil Demand Up

Total demand for crude oil and products in the U. S. will amount to about 8,000,000 bbl per day in 1953, the Bureau of Mines has reported. Domestic demand is expected to rise 4.9 per cent over that of 1952, and 3.8 per cent for total demand. Exports are expected to drop about 16 per cent to an average of 354,000 bbl daily for the year, the Bureau of Mines reported. Crude runs to stills will average 6,863,000 bbl daily.

FPC Red Tape Hit

Governmental red tape in the Federal Power Commission has been attacked by Charles I. Francis, vice president of Texas Eastern Transmission Corporation. Speaking before the annual institute of oil and gas law and taxation at Southwestern Legal Center on the Southern Methodist University campus recently, Francis said, "multitudinous procedures and practices of the commission complicate settlement of problems under its jurisdiction." Some red tape must be untangled if the industry is to move forward, Francis added. More than 500 oil men attended the meeting.

Murchison Featured in Fortune

Clint Murchison, Dallas, Texas, oil man, was featured in Fortune magazine recently. The article traces the life of Murchison and touches on his many interests including his founding and building of the Southern Union Gas Company, American Liberty Oil, and Delhi Oil Company.

Oil Industry Problems Await President Eisenhower

The new administration under the leadership of President Eisenhower faces a maze of oil problems left unsolved by the Democratic regime. Problems that no matter how he solves them, could be misinterpreted by the general public. Selling the public on his decisions and making them understand *why* such decisions were made will be Eisenhower's most important battle.

Tideland. Of probable equal importance is the tidelands question and the Iran-Anglo-Iranian dispute. The tidelands situation was further complicated when Truman issued an edict giving them to the Navy as Naval Petroleum Reserves. If Eisenhower gives them to the states how will he convince the general public he is doing what is best — that the Navy can buy oil from independent oil companies cheaper than it can develop the tidelands?

Iran Oil. Rumors persist that the dispute may be settled within a matter of days, but in all probability the Republican Congress will spend many weary hours seeking a way out of the crisis between Iran and Great Britain. If, however, the problem is settled soon and oil begins flowing from the Abadan refinery and from the tidelands what will happen to the market? Will the supply exceed the demand to such an extent as to knock our price structure askew? More demand for oil will have to be created — something else for the new president to worry about.

Cartel. The Justice Department's anti-cartel case against seven international oil companies, five of them American, has been left up to the Eisenhower group with all its potential explosive reaction. The National Security Council has voted to drop charges against the companies, but when Attorney General McGranery approached oil attorneys he suggested a civil suit in place of criminal action if the companies would produce records formerly asked for. Attorneys refused and the entire case has been dropped intact in the laps of the GOP government.

Oil Charges. But that is not the only case that will be decided by the new group of congressmen. Other charges were recently brought by the Justice Department against seven oil companies. The government claims it has been overcharged $67,000,000 on foreign aid oil shipments and has demanded a return of the money.

Price Control. Much pressure will be applied in Washington in the coming weeks to drop price control. Eisenhower has said he favors decontrolling prices but with the danger of inflation still lurking close by, what would happen if prices did get out of control? Or will the law of supply and demand take over and block any inflationary trend after a momentary adjusting period. That is something the new congressmen will have to decide.

These are some of the more potent problems in the oil industry awaiting the congress. Other industries will have their problems too.

Oil Search in England

British scientists are looking hopefully at what may prove to be a major oil find in that country. Oil was discovered accidentally during a search for coal at Cronton near Widnes recently, and core samples from the mineral borings indicate a major source of oil may be found. A Manchester official of the geological survey, compared the strike with that at Formby in Lancashire, where Anglo-Iranian Oil Company has brought in several shallow oil wells.

Although no actual drilling has been done, a scientific report revealed that "the sandstone was heavily impregnated and oil oozed out of it."

Wilson Talks Back

Robert E. Wilson, chairman of the board, Standard Oil Company (Indiana) has lashed out at the Federal Trade Commission in the January 24 issue of *The Saturday Evening Post*. He vehemently denies charges which he states are being made "especially against large companies" in American industry, and asserts that "bigness" is not synonymous with "badness."

Record Oil Output Seen

Lewis W. MacNaughton, partner in DeGolyer and McNaughton, told an oil and gas institute, sponsored by Southwestern Legal Foundation, that oil operators in the U. S. will eventually produce 200 billion barrels of crude oil. He added that he believed 1 trillion barrels of oil eventually will be produced in the world, "though even that won't meet the global demand in years to come. The world now produces 12,500,000 bbl daily.

How Many Kinds of Engineers?

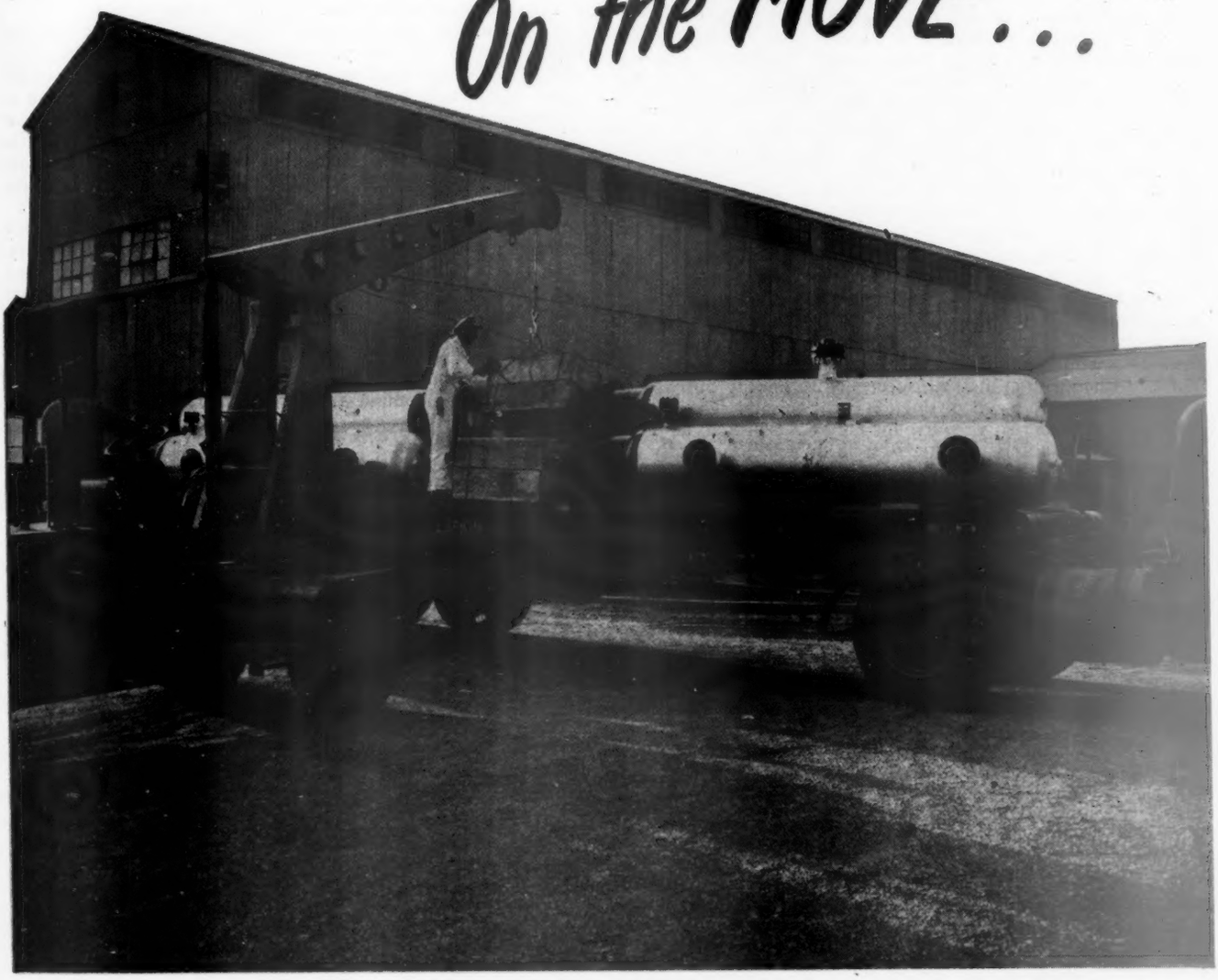
When C. W. Scamman called about the National Society of Professional Engineers' annual meeting in Houston, Texas, February 22, he brought up the interesting question of how many different kinds of engineers there are in the oil and gas industry. We made an attempt to name them and came up with these: Mining, metallurgical, mechanical, mud, chemical, electric, electronic, production, pipe line, corrosion, lubrication, refining, civil, process, research, maintenance, design, treating, steam, and automotive.

Oil Fields Dress Up

California oil companies are making their oil fields look like well-kept state parks, in answer to home-owners rather hostile complaints of the unsightly clutter and equipment. Oil men have made their pumping installations without odor, sound, and in some cases invisible. Union Oil of California was a pioneer in the art of redecorating the oil fields. Drill sites were put behind hills or in canyons; wells were clustered in "drilling islands."

PEERLESS SEPARATORS

On the MOVE...



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DICK SNEDDON

Roy Fly Threatens Congressional Immunity

Roy Fly, the good-looking, mild-mannered, young Western Gulf purchasing agent, left Los Angeles for Washington, D. C., in early January, to take over as assistant director of the Materials Division, Foreign Coordination, Petroleum Administration for Defense, and long before we have all memorized that classic piece of titular ponderosity, Roy will probably be an old man with a long white beard. The lad who manufactures titles in Washington must be paid so much per syllable judging by the peripharastic atrocities that come out of the nation's capital. But all of that will have little effect on the imperturbable Roy who is one of our favorite people out here in California. He is actually a native of Columbia, Tennessee; finished his academic training for the battle of life at Oklahoma A & M, and then attached himself to Gulf Oil Corporation in Tulsa.

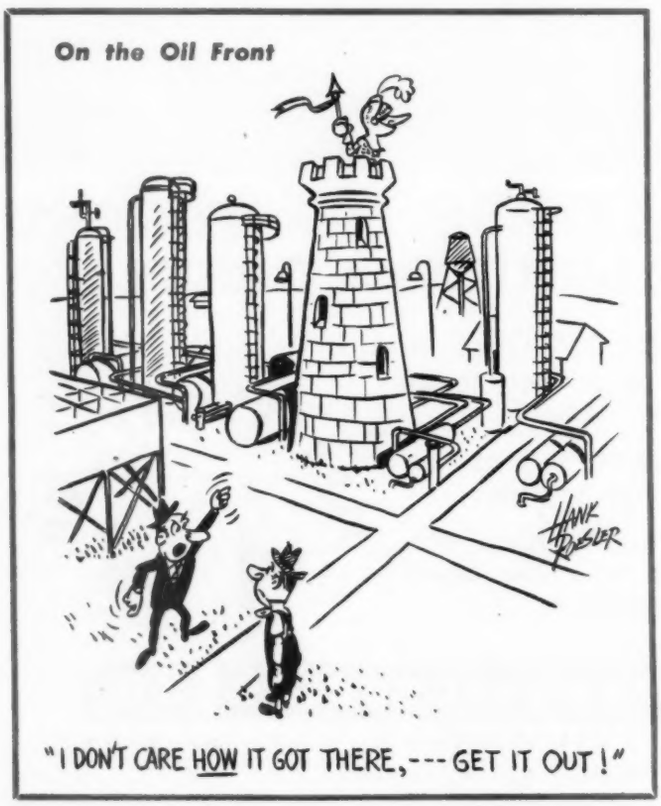
After five years of diverse experience in such scattered areas as Kansas, Illinois, and Oklahoma, he was moved to the Western Gulf headquarters at Los Angeles as an accountant. In 1946 he was appointed assistant purchasing agent, and on the death of Chet Yocum in 1949, succeeded to the top purchasing spot which he held with distinction until this latest elevation. Roy is a Nineteener so of course his hobby is golf, and he plays a sharp game. There is another exercise in which he really excels, however, and we'd just like to warn the senators and congressmen in Washington that if they don't enjoy losing at gin rummy, it's better not to invite Roy to play.

A Thing of Beauty and a Joy Forever

Phil Magruder, the ruling prexy of the Los Angeles Petroleum Club, and his fellow members, now numbering approximately 700, are mighty proud of their elegant new quarters in the Statler Hotel, and they will never have better reason to puff. The entire layout, which was opened formally on January 9, is about as enticing as anything of the kind we have seen in a long time. The color scheme is predominately soft tans, browns, and greens, with an occasional blaze of red for warmth, all of which resolves itself into a very pleasing and tasteful blend. The Statler space is three times what the Club commanded at its former locale in the Biltmore, and the new appointments make it altogether one of the most restful and appealing retreats in the bustling western metropolis.

Stan Natcher, the Standard of California biggie, gets the royal accolade for his part in this master production. Stan officiated through 1952 as vice president and chairman of the house committee, and to this latter was entrusted the job of supervising and directing the interior design and furnishing of the Club suite, which they certainly did with distinction. On Stan's committee were such other notables as Tom Sherman, Joe Hudson, Ham Bell, Basil Kantzer, Wendell Jones, and Rollin Eckis.

We rather imagine that the original incorporators, Henry Salvatori, Paul Huggins, Tom and Dick Sherman, Jim Leovy, O. I. "Tork" Torkelson, Stan Williams, Frank Morgan, and Mortimer Kline, are thrilled beyond words at this current demonstration of their sound judgment. The Club in its present form is a real asset to the western petroleum industry and we predict that it is going to be a very popular resort in the years to come. Personally, in such agreeable surroundings, we expect to lose our domino games with much better grace.



Exciting News From the Domino Front

On the subject of dominoes, whom should we engage in a recent lunch hour joust but Bob Smith, the stratospheric tenor, sometimes called the Clarence Darrow of the Sunray, and that famed Indianan, Nate Isenberger, foreign consultant for the Phillips Petroleum Company of Bartlesville, Oklahoma. By keeping the double-five constantly in sight; doing some extremely expert drawing; playing close attention to the advice of kibitzer, Paul Broxon, the Western Gulf legal whiz; and choosing Ed McDowd, the Shell scout, for a partner, we managed to stagger out of this affray with nothing worse than surface abrasions, but the doc has ordered a course of sedatives to calm the jittering butterflies in our innards.

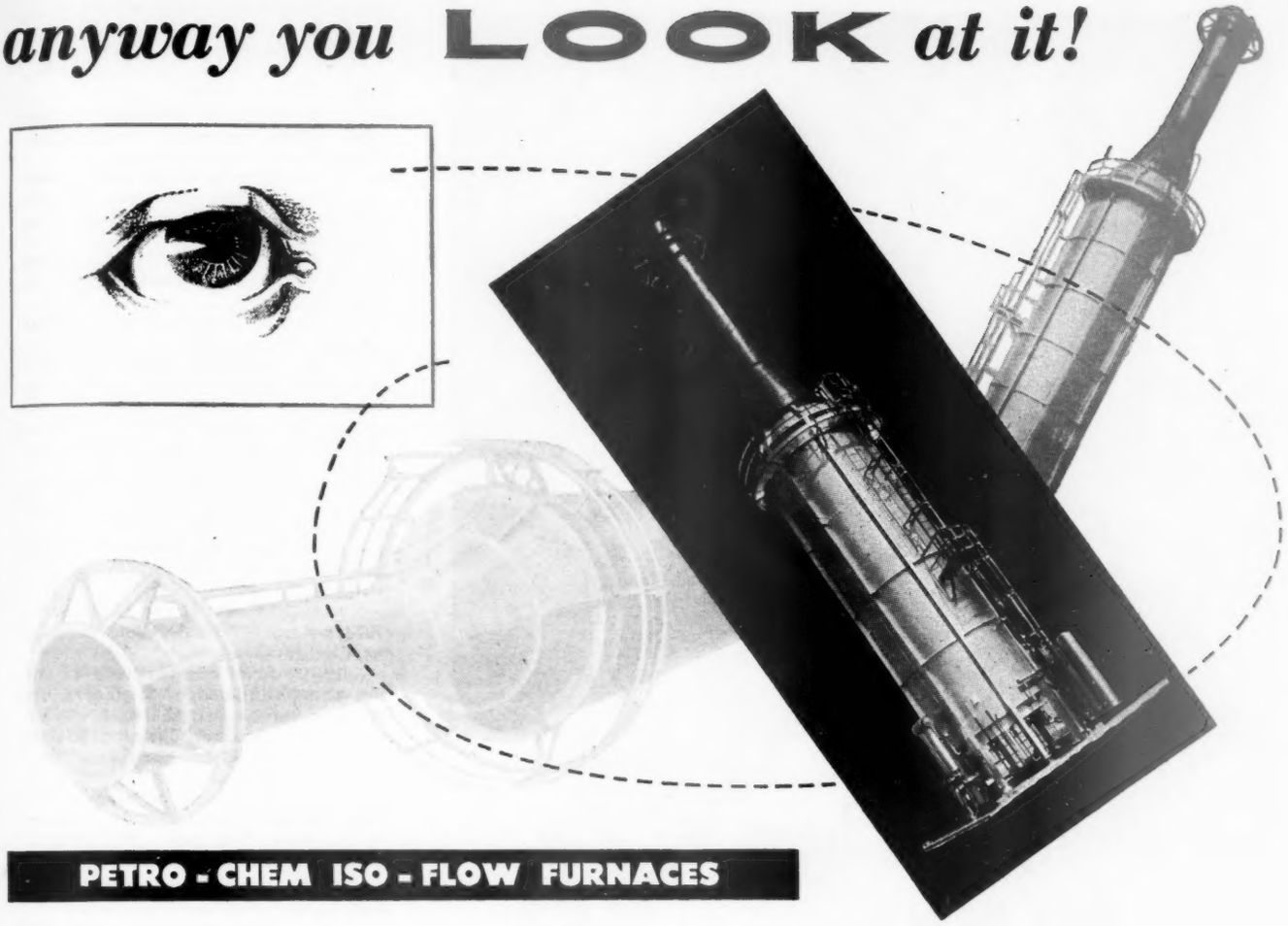
By the way, the Forbes Magazine scooped us on the Nate Isenberger story, but, shucks, we run scads of stories that Forbes never even hears about, so they needn't get cocky about it. Anyway, for your especial information, Nate is a son of Albany, Indiana; was graduated from University of Kansas in geological engineering, and has traveled all over the Latin Americas, picking up consequential petrolic data. He has now been a considerable attachment of the Phillips organization for some 20 years and besides being one of the sharpest spotted-tile tossers in the Sooner State, is dangerous on a golf course.

News From the Far North

Took a flyer to Santa Maria the other day as guest of Pick McIver, the Shell Company crude oil procurement chap, and had a lovely time consorting with our northern neighbors and their visitors. Along the way we dropped by to see Harry Long's operations on the Basola lease in Shiell's Canyon and found everything going well excepting that Harry had inadvertently parked his new Cadillac in a muskeg and the transportation department was for the moment badly gummed up. In the evening we attended the monthly meeting of the Santa Maria Club, where in addition to having a barbecued dinner that was fit for a king, we bumped into such petrolic notables at Ed Howe, the genial Jones & Laughlin metallurgist, all the way from Pittsburg, and Bob Shearer, Los Angeles district manager for the same august institution.

Then there were Kenny Forde and Clyde Allison, a substantial duo from Sunray Company; Mel Hill and Gordon Bell, a neat pair of Western Gulf geologists; Charlie Eastman, the ubiquitous California Production Service exec; Ed Larson, the friendly McCullough Tool district sales chief; and a stash of Union Oilers, including Johnny Sherborne, Homer Law, Bill Butler, Barney Brison, Mel Chappell, Bill Arnold, Porter Clevenger, and John Sleath, all of whom it was good to see. We toted Bob Shearer back to L. A., and between Pick's pipe and Bob's Caledonian brogue, the air in the limousine became so thick, it reminded us of the time that, for a dare, we smoked a strong cigar in a closed telephone booth.

anyway you LOOK *at it!*



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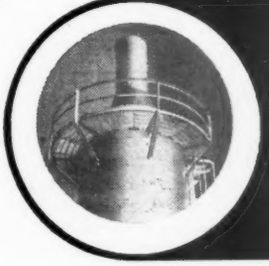

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Meetings

Feb. 12-13—**Western Petroleum Refiners Association,** regional meeting, Beaumont Hotel, Beaumont, Texas.

Feb. 16-18—**American Petroleum Institute,** Division of Marketing, Lubrication committee meeting, Sheraton-Cadillac, Detroit, Michigan.

Feb. 18—**Instrument Society of America,** annual meeting, Hotel Statler, New York City, New York.

Feb. 22—**National Society of Professional Engineers,** annual meeting, Houston, Texas.

Feb. 27—**Natural Gasoline Association of America,** region 1 meeting, Scarbauer Hotel, Midland, Texas.

March 2-6—**American Society for Testing Materials,** spring meeting, Statler Hotel, Detroit, Michigan.

March 4-6—**American Petroleum Institute,** Division of Production, Southwestern District, Hilton Hotel, Fort Worth, Texas.

March 8-11—**American Institute of Chemical Engineers,** Buena Vista Hotel, Biloxi, Mississippi.

March 9-12—**National Electrical Manufacturers Association,** Edgewater Beach Hotel, Chicago, Illinois.

March 15-19—**American Institute of Mining and Metallurgical Engineers,** Statler Hotel, Los Angeles, California.

March 15-19—**American Chemical Society,** national meeting, Hotels Biltmore and Statler, Los Angeles, California.

March 18-20—**American Petroleum Institute,** Division of Production, Mid-Continent District, Mayo Hotel, Tulsa, Oklahoma.

March 16-20—**Association of Corrosion Engineers,** national meeting, Hotel Sherman, Chicago, Illinois.

March 19-21—**Texas Oil Jobbers Association Inc.,** annual convention, The Plaza Hotel, San Antonio, Texas.

March 23-25—**Western Petroleum Refiners Association,** annual meeting, Plaza Hotel, San Antonio, Texas.

March 23-27—**American Association of Petroleum Geologists, Society of Economic Paleontologists and Mineralogists and Society of Exploration Geophysicists,** joint annual meeting, Rice and Shamrock Hotels, Houston, Texas.

March 23-27—**American Society for Metals, Western Metal Congress and Exposition,** Pan-Pacific Auditorium, Statler Hotel, Los Angeles, California.

March 28—**North Texas Oil and Gas Association,** annual meeting, Kemp Hotel, Wichita Falls, Texas.

March 30-31—**Texas Independent Producers and Royalty Owners Association,** annual meeting, San Antonio, Texas.

March 30-April 1—**Mid-West Gas Association,** Broadmoor Hotel, Colorado Springs, Colorado.

April 8-10—**American Petroleum Institute,** Division of Production, Eastern District spring meeting, Hotel William Penn, Pittsburgh, Pennsylvania.

April 12-May 23—**Empire Mining and Metallurgical Congress,** Australasian Institute of Mining and Metallurgy, Australia.

April 13-15—**American Society of Lubrication Engineers,** annual meeting and exhibit, Hotel Statler, Boston, Massachusetts.

April 13-15—**Canadian Institute of Mining and Metallurgy,** annual meeting, The McDonald, Edmonton, Alberta, Canada.

April 13-15—**Association of Nebraska Liquefied Petroleum Gas Dealers,** annual meeting, Hotel Fontenelle, Omaha, Nebraska.

April 15-17—**National Petroleum Association,** semi-annual meeting, Hotel Cleveland, Cleveland, Ohio.

April 20-22—**American Petroleum Institute,** Division of Transportation, products pipe line conference, Hotel Muehlebach, Kansas City, Missouri.

April 21 — **Association of Consulting Chemists and Chemical Engineers, Inc.,** Hotel Belmont Plaza, New York, New York.

April 21-23—**Southwestern Gas Measurement Short Course,** University of Oklahoma, Norman, Oklahoma.

April 22-24—**American Institute of Electrical Engineers,** South district No. 4, Louisville, Kentucky.

April 24-25—**Interstate Oil Compact Commission,** spring meeting, Roosevelt Hotel, New Orleans, Louisiana.

April 26-29—**American Institute of Chemical Engineers,** joint meeting with **Chemical Institute of Canada,** Royal York Hotel, Toronto, Canada.

April 27-28—**Independent Petroleum Association of America,** mid-year meeting, Jefferson Hotel, St. Louis, Missouri.

April 29-May 1—**Natural Gasoline Association of America,** annual convention, Rice Hotel, Houston, Texas.

May 4-6—**Liquefied Petroleum Gas Association,** annual convention, Conrad Hilton Hotel, Chicago, Illinois.

May 7-8—**American Petroleum Institute,** Division of Production, Rocky Mountain district, Gladstone Hotel, Casper, Wyoming.

May 10-12—**Pennsylvania Petroleum Association, Inc.,** Bedford Springs Hotel, Bedford Springs, Pennsylvania.

May 11-13—**Southern Gas Association,** Jung Hotel, New Orleans, Louisiana.

May 11-14 — **American Petroleum Institute,** Division of Refining, Hotel Commodore, New York, New York.

May 14-23—**International Petroleum Exposition,** Tulsa, Oklahoma.

May 24-27—**American Gas Association,** production and chemical conference, Hotel New Yorker, New York, New York.

May 27-29—**Short Course in Gas Technology,** annual, Texas College of Arts and Industries, Kingsville, Texas.

May 28-29—**Natural Gas and Petroleum Association of Canada,** London, Ontario, Canada.

June 2-3—**American Petroleum Institute,** Division of Production, Pacific Coast District, Statler Hotel, Los Angeles, California.

June 7-12—**Society of Automotive Engineers,** summer meeting, The Ambassador and Ritz-Carlton, Atlantic City, New Jersey.

June 15-19—**American Petroleum Institute,** Division of Production, mid-year committee conference, Hotel William Penn, Pittsburgh, Pennsylvania.

API GROUP TO MEET

The 1953 meeting of the Southwestern District, American Petroleum Institute, is scheduled for March 4, 5 and 6 in Fort Worth, Texas.

March 4 will be devoted to meetings of the drilling and production practice and training committees. A social event is tentatively scheduled for the evening. March 5 and 6 will be devoted to general and technical group sessions, the speakers to be announced later.

The major social event of the session is scheduled for the evening of March 5.

The Hilton Hotel and the Texas Hotel are designated as headquarters for the meeting.

F. E. Hatfield, Gulf Oil Corporation, is general chairman of the arrangements committee. Vice-chairman is Madison I. Taylor of Gulf Oil Corporation.

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June 16-19—**American Welding Society,** national spring technical meeting, Shamrock Hotel, Houston, Texas.

June 16-24 — **European Congress for Chemical Engineering,** Paris, France.

June 18-19 — **Pennsylvania Grade Crude Oil Association,** annual meeting, Hotel William Penn, Pittsburgh, Pennsylvania.

June 29-July 3—**American Society for Testing Materials,** annual meeting, Chalfonte-Haddon, Atlantic City, New Jersey.

August 31-Sept. 5—**International Association for Hydraulic Research,** arranged jointly with Hydraulics Division of the **American Society of Civil Engineers,** Minneapolis, Minnesota.

Sept. 1-3—**Interstate Oil Compact Commission,** summer meeting, Banff Springs Hotel, Banff, Alberta, Canada.

Sept. 6-11—**American Chemical Society,** national meeting, Conrad Hilton Hotel, Chicago, Illinois.

Sept. 10-11—**Desk and Derrick Clubs of North America,** annual convention, Denver, Colorado.

Sept. 13-16—**American Institute of Chemical Engineers,** Fairmont and Mark Hopkins Hotels, San Francisco, California.

Sept. 16-18—**National Petroleum Association,** annual meeting, The Traymore, Atlantic City, New Jersey.

Sept. 21-25—**Instrument Society of America,** conference and exhibit, Chicago, Illinois.

Sept. 24-25—**Western Petroleum Refiners Association,** regional meeting, Henning Hotel, Casper, Wyoming.

Oct. 8-9—**National Conference on Industrial Hydraulics,** annual meeting, Hotel Sheraton, Chicago, Illinois.

Oct. 19-20—**Independent Petroleum Association of America,** annual meeting, Hotel Texas, Fort Worth, Texas.

Oct. 19-23—**National Safety Congress,** Conrad Hilton, Congress, Morrison, Sheraton Hotels, Chicago, Illinois.

Oct. 26-29—**American Gas Association,** annual conference, Kiel Auditorium, St. Louis, Missouri.

November 2-4—**Society of Automotive Engineers,** national transportation meeting, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 5-6—**Society of Automotive Engineers,** national fuels and lubricants division, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 9-11—**The Geological Society of America,** annual meeting, Royal York Hotel, Toronto, Canada.

Nov. 9-12—**American Petroleum Institute,** annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 30-Dec. 5—**Exposition of Chemical Industries,** Grand Central Palace, New York New York.

Nov. 30-Dec. 5—**American Society of Mechanical Engineers,** annual meeting, Hotels Statler and McAlpin, New York, New York.

NOMADS TO MEET

New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's New York. Secretary, O. B. Latrobe.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary, Harry E. Estes.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Executive Secretary Wallace A. Sawdon.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary Gilbert Swift.

Dallas-Fort Worth Chapter, Dallas, Texas. First Monday of the Month.

APPROXIMATE HORSE POWER REQUIRED FOR POWER SLUSH PUMP OPERATION

Working pressure, lb. per sq. in.	1100			1200			1300			1400			1500		
Pump speed r.p.m.	40	50	60	40	50	60	40	50	60	40	50	60	40	50	60
Pump size															
4½ x 10	83	104	125	91	114	136	98	123	148	106	132	159	114	142	170
4¾ x 10	93	116	139	101	126	152	110	137	164	118	148	177	126	158	190
5 x 10	103	129	154	112	140	168	122	152	182	131	164	196	140	175	210
5¼ x 10	113	142	170	124	155	185	134	167	201	144	180	216	155	193	232
5½ x 10	124	155	187	136	170	204	147	184	221	158	198	237	170	212	254
5¾ x 10	136	170	204	148	185	222	161	201	241	173	216	260	185	232	278
6 x 10	148	185	222	161	202	242	175	219	262	188	236	283	202	252	303
6¼ x 10	161	201	241	175	219	263	190	237	285	204	256	307	219	274	329
6½ x 10	174	217	261	190	237	284	205	257	308	221	276	332	237	296	355
6¾ x 10	187	234	281	204	255	307	221	277	332	238	298	358	255	319	382
7 x 10	201	252	302	220	275	330	238	298	357	256	321	385	275	343	412
7¼ x 10	216	270	324	236	295	354	255	319	383	275	344	413	295	368	442
4½ x 12	100	125	150	109	136	164	118	148	170	127	159	191	136	170	204
4¾ x 12	111	139	167	121	152	182	132	165	197	142	177	213	152	190	228
5 x 12	123	154	185	135	168	202	146	182	219	157	196	236	168	210	252
5¼ x 12	136	170	204	148	185	223	161	201	241	173	216	260	185	232	278
5½ x 12	149	187	224	163	204	244	176	221	265	190	237	285	204	254	305
5¾ x 12	163	204	245	178	222	267	193	241	289	208	260	311	222	278	334
6 x 12	178	222	266	194	242	291	210	262	315	226	283	339	242	303	363
6¼ x 12	193	241	289	210	263	315	228	285	342	245	307	368	263	329	394
6½ x 12	208	261	313	227	284	341	246	308	370	265	332	398	284	355	426
6¾ x 12	225	281	337	245	307	368	266	332	399	286	358	429	307	383	460
7 x 12	242	302	363	264	330	396	286	357	429	308	385	462	330	412	495
7¼ x 12	259	324	389	283	354	424	307	383	460	330	413	495	354	442	531
5 x 14	144	180	216	157	196	236	170	213	255	183	229	275	196	245	294
5¼ x 14	159	198	238	173	216	260	188	234	281	202	252	303	216	270	325
5½ x 14	174	218	261	190	237	285	206	257	309	222	277	332	237	297	356
5¾ x 14	190	238	286	208	260	311	225	281	337	242	303	363	260	324	389
6 x 14	207	259	311	226	283	339	245	306	367	264	330	396	283	353	424
6¼ x 14	225	281	337	245	307	368	266	332	399	286	358	429	307	383	460
6½ x 14	243	304	365	265	332	398	287	359	431	310	387	464	332	415	498
6¾ x 14	262	328	393	286	358	429	310	388	465	334	417	501	358	447	537
7 x 14	282	353	423	308	385	462	333	417	500	359	449	539	385	481	577
7¼ x 14	303	378	454	330	413	495	358	447	536	385	481	578	413	516	619
5 x 15	154	193	231	168	210	252	182	228	273	196	245	294	210	263	315
5¼ x 15	170	212	255	185	232	278	201	251	301	216	270	325	232	290	348
5½ x 15	187	233	280	204	254	305	221	276	331	238	297	356	254	318	382
5¾ x 15	204	255	306	222	278	334	241	301	362	260	324	389	278	348	417
6 x 15	222	278	333	242	303	363	262	328	394	283	353	424	303	378	454
6¼ x 15	241	301	361	263	329	394	285	356	427	307	383	460	329	411	493
6½ x 15	261	326	391	284	355	426	308	385	462	333	415	498	355	444	533
6¾ x 15	281	351	422	307	383	460	332	415	498	358	447	536	383	479	575
7 x 15	302	378	453	330	412	495	357	447	536	385	481	577	412	515	618
7¼ x 15	324	405	486	354	442	531	383	479	575	413	516	619	442	553	663
x 16	164	206	247	179	224	269	194	243	292	209	262	314	224	280	336
5¼ x 16	181	227	272	198	247	297	214	268	321	231	289	346	247	309	371
5½ x 16	199	249	299	217	271	326	235	294	353	253	317	380	271	339	407
5¾ x 16	218	272	326	237	297	356	257	321	386	277	346	415	297	371	445
6 x 16	237	296	355	258	323	388	280	350	420	301	377	452	323	404	484
6¼ x 16	257	321	386	280	350	421	304	380	456	327	409	491	350	438	526
6½ x 16	278	347	417	303	379	455	329	411	493	354	442	531	379	474	569
6¾ x 16	300	375	450	327	409	491	354	443	531	382	477	572	409	511	613
7 x 16	322	403	484	352	440	528	381	476	572	410	513	615	440	550	659
7¼ x 16	346	432	519	377	472	566	409	511	613	440	550	660	472	589	707
7½ x 16	370	463	555	404	505	606	437	547	656	471	589	707	505	631	757
7¾ x 16	395	494	593	431	539	647	467	584	701	503	629	754	539	674	808
5 x 18	185	231	278	202	252	303	219	273	328	236	294	353	252	315	378
5¼ x 18	204	255	306	223	278	334	241	301	362	260	325	389	278	348	417
5½ x 18	224	280	336	244	305	366	265	331	397	285	356	427	305	382	458
5¾ x 18	245	306	367	267	334	400	289	362	434	311	389	467	334	417	501
6 x 18	266	333	400	291	363	436	315	394	472	339	424	509	363	454	545
6¼ x 18	289	361	434	315	394	473	342	427	513	368	460	552	394	493	591
6½ x 18	313	391	469	341	426	512	370	462	554	398	498	597	426	533	640
6¾ x 18	337	422	506	368	460	552	399	498	598	429	537	644	460	575	690
7 x 18	363	453	544	396	495	593	429	536	643	462	577	692	495	618	742
7¼ x 18	389	486	584	424	530	637	460	575	690	495	619	743	530	663	796
7½ x 18	416	520	625	454	568	681	492	615	738	530	662	795	568	710	852
7¾ x 18	445	556	667	485	606	727	525	657	788	566	707	849	606	758	909
5 x 20	206	257	308	224	280	336	243	304	365	262	327	393	280	350	421
5¼ x 20	227	283	340	247	309	371	268	335	402	289	361	433	309	386	464
5½ x 20	249	311	373	271	339	407	294	368	441	317	396	475	339	424	509
5¾ x 20	272	340	408	297	371	445	321	402	482	346	433	519	371	464	556
6 x 20	296	370	444	323	404	484	350	437	525	377	471	565	404	505	606
6¼ x 20	321	402	482	350	438	526	380	475	570	409	511	613	438	548	657
6½ x 20	347	434	521	379	474	569	411	513	616	442	553	663	474	592	711
6¾ x 20	375	468	562	409	511	613	443	554	664	477	596	715	511	639	766
7 x 20	403	504	604	440	549	659	476	595	714	513	641	769	549	687	824
7¼ x 20	432	540	648	471	589	707	511	638	766	550	688	825	589	737	884
7½ x 20	463	578	694	505	631	757	547	683	820	589	736	883	631	789	946
7¾ x 20	494	617	741	539	673	808	584	730	876	629	786	943	673	841	1010

The chart gives the approximate brake horsepower required for power slush pump operation, based on the pump having a mechanical efficiency of 85%. The following formula was used in computing the figures.

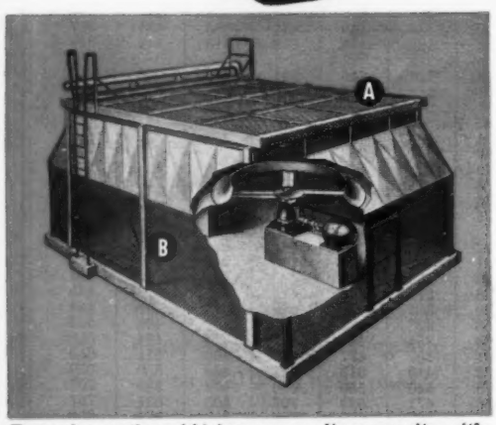
$$\text{H. P.} = \frac{\text{Fluid Cylinder dia. squared} \times \text{stroke} \times \text{R.P.M.} \times \text{Pressure}}{107{,}000}$$

To determine the power required for a given condition, select the diameter of the fluid piston and the proper length stroke. Opposite this is shown the approximate brake horsepower for all conditions from 1100 to 1500 lb. fluid-end working pressure, based on 40, 50, and 60 r.p.m. of the pump.

In applying an internal combustion engine to slush pump operation only the continuous duty horsepower value should be used as power slush pump operation in drilling service is considered as a continuous load.

NOTE: Before high pressures are imposed on older pumps, it should be ascertained whether pump is designed to withstand such service.

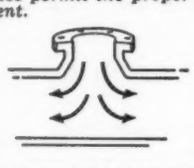
Announcing the NEW improved . . . .



Transaire sections (A) increase cooling capacity without increasing horsepower. They are adaptable to almost any duty involving pressure to 5,000 psi and temperatures to 1,500°F. Fluor steel structures (B) are prefabricated to simplify field erection. Gears and fans in many sizes permit the proper combination for every requirement.

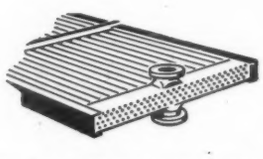
The new Fluor Fin-Fan now comes equipped with *Transaire Sections,* an improved heat transfer surface that holds velocity pressure loss to a minimum, provides smoother flow into and out of tubes, increases the safety factor, reduces operating and maintenance costs and can be assembled and dismantled for cleaning and replacements more easily than any other air-cooled heat exchanger of conventional design.

Fluor structures and mechanical equipment, with a remarkable field performance record since 1940, have been retained. Now for the first time the Fluor Fin-Fan is completely selected and supplied by Fluor. More Fluor Fin-Fans are in operation throughout the world today, and regardless of wind and water conditions, you can depend on Fluor Fin-Fans for dependable cooling service.



Less pressure drop. Inlet and outlet nozzles in the header-manifold widen out below the flange for smoother flow through the section and with less pressure drop. Area of these openings is equal to a full pipe cross-sectional area. Countersunk tube holes inside the header reduce turbulence.

More heat transfer surface. Tubes are helically wrapped with a crimped fin which presents more metal-to-metal contact and more contact to passing air for greater dissipation of heat. Tubes and fins are available in a choice of materials. Single units can be used for multiple duties.



Four-to-one safety factor. Headers are either cast iron or fabricated steel and in either case are *unconditionally guaranteed* to withstand test pressures of four times the design pressure. Brass header plugs provide quick easy access to tube ends for cleaning without requiring special tools.

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For complete information on Fluor Fin-Fans write for Bulletin FF-1535-2.

LETTERS

Practice Proves Theory

To The Petroleum Engineer:

When we wrote an article for *The Petroleum Engineer* on the subject of "Basal Lower Cretaceous Accumulations in Alberta" with special reference to the Campbell pool, we pointed out the possibility of Devonian productive reefs in the general Campbell area, in connection with its favorable location along a pronounced reef trend and the fact that high gravity Lower Cretaceous accumulations might be indicative of a Paleozoic reservoir in the immediate vicinity.

We therefore believe that you will be interested to learn that last week the Stanolind Imperial St. Albert No. 1 well in LSD 3, Sec. 1, Twp. 54, Rge. 25 was reported to flow oil to the surface on a drillstem test in the Devonian D2 (Nisku). Crew is now coring and drilling ahead in search of the D3.

The well found both the Viking and Basal Lower Cretaceous sands to be productive on previous tests, which appears to support our theory.

We have been aware of the excellent chances of finding Devonian production in the immediate vicinity of the Roxboro Big Lake No. 1 well and therefore followed the Stanolind Imperial St. Albert No. 1 discovery well with special interest. We could not, however, predict that Devonian reef production would be found before the appearance of our article in *The Petroleum Engineer*.

P. Klaui

Trafford and Associates

Romance of the Cable Rigs

To The Petroleum Engineer:

I have been interested in the oil industry since the early 1920's, having been with Carter Oil when they drilled on the San Rafel Swell. I was road foreman at the time, but between washouts and road building and repairing I spent every minute I could at the rig. I expect I was in the way at times but the drillers were good natured and soon were explaining and showing me the why and wherefore of what they were doing. I listened and helped all I could until I got the hang of the job. Those old cable rigs of that time were romantic to me. Did you ever swing a sixteen pound sledge on a twenty-two inch bit that had been heated red hot with a big kerosine blow torch, listened to the whirr of the cable going up or down, and the sound of the walking beam and drill like which there is no other sound? Then you know what I mean.

L. E. Howard

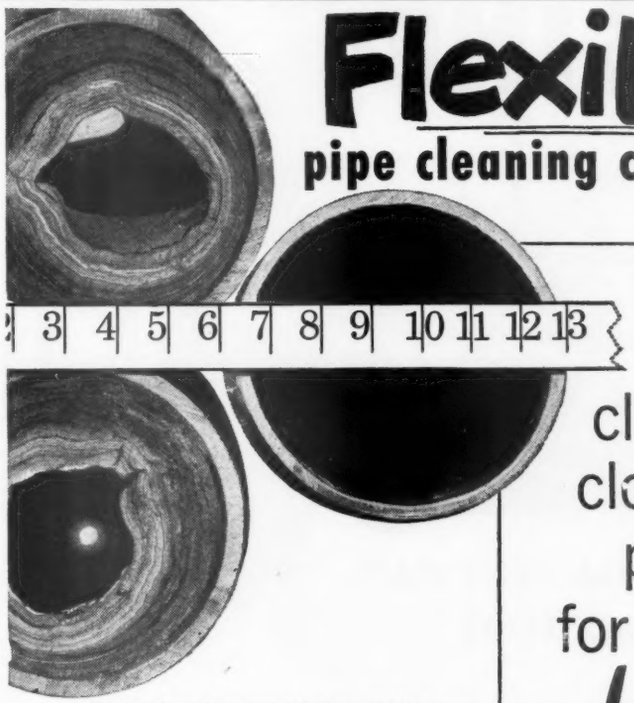
Salt Lake City, Utah

Sand Withdrawal

To The Petroleum Engineer:

Having just read your interesting (and for a geologist difficult) summary of subsidence in California (Does Oil Withdrawal Cause Earthquakes? Page A-59, October, 1952). I should like to ask you one question, namely, has anybody considered the factor sand withdrawal? That is what is the effect upon subsidence of the sand actually withdrawn (brought to surface) during producing operations. Very often this sand production is not measured or it is logged as so much per cent basic sediment. Now, assuming that a well makes over its life 0.1 per cent basic sediment, half of which is sand, per barrel of oil, and let us assume the ultimate of the well is 100,000 bbl, then this means that the well during its life produces 50 bbl of actual sand. This sand has been removed bodily and has left voids behind it in the producing formation. For a time these voids are filled with oil but of different compressibility than the original formation.

The figure of 50 bbl of sand is very low in my experience and a figure 10 times as high if not 100 times as high may be more normal. Therefore, the effect of sand withdrawal may be significant and I suggest — if this has not been done already — that someone make a study of sand production of all wells in the vicinity and plot the results on a map, together with the contours of sub-



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Clogged underground pipe is the costliest pipe you can own or operate! Every particle of scale and rust deposited on the pipe wall cuts capacity, skyrockets your pumping and operating costs.

You, no doubt, are considering *replacing* this clogged pipe. But before you consider pipe replacement, remember this – Flexible Pipe Cleaning Company can *clean* that clogged line – return it to guaranteed 95% efficiency – and AT A FRACTION OF REPLACEMENT COST! For example, new 10" steel line, 30" underground costs at least $6.00 per foot wrapped and laid. Tees and crosses are extra. Flexible can *clean* that SAME LINE FOR ABOUT 18¢ PER FOOT – *or 1/30th the cost of replacement!*

How much to clean your clogged lines? Send for our Preliminary Job Cost Estimate form. Take five minutes to complete this form and return it to us. We'll give you a free estimate on the cost of cleaning your pipe – stacked, stored or underground. Our crews are near you.

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CASE

sidence. A significant correlation might appear.

A further question would aim at a study of the effects of faulting. Geological bodies, being inhomogeneous, normally react to stresses by faulting, in this case micro-faulting, and this might affect in detail the distribution of subsidences, too.

H. H. Suter

Geologist,
Trinidad Leaseholds (Canada), Ltd.
20 Alberta Block, 1st Str. W.
Calgary, Alberta, Canada.

Editor's note: I must confess that, although I have frequently been involved in discussions of the abrasive and other adverse effects of formation sand in oil, I have never thought of the withdrawal of sand in relation to earth subsidence. It would seem quite logical, however, to expect some connection between the two and it is not unlikely that others more intimately concerned with the problem have studied the relationship. If there are such, Mr. Suter's letter will no doubt stimulate them to appropriate comment. If, actually, nothing of consequence has been done by way of study, the effects of sand withdrawal on earth subsidence would seem to offer an interesting channel of research for reservoir and production engineers. — R. S.

Cartoon Request

To The Petroleum Engineer:

In your issue for November, 1952, there appears a sketch by Hank Roesler under caption "On the Oil Front."

This company, as you will be aware, possesses oil producing interests in Burma and Pakistan, and we should be much obliged if you could see your way to permitting us to reproduce this amusing item in the company's House Magazine next issue, in June 1953.

E. B. Poeglear

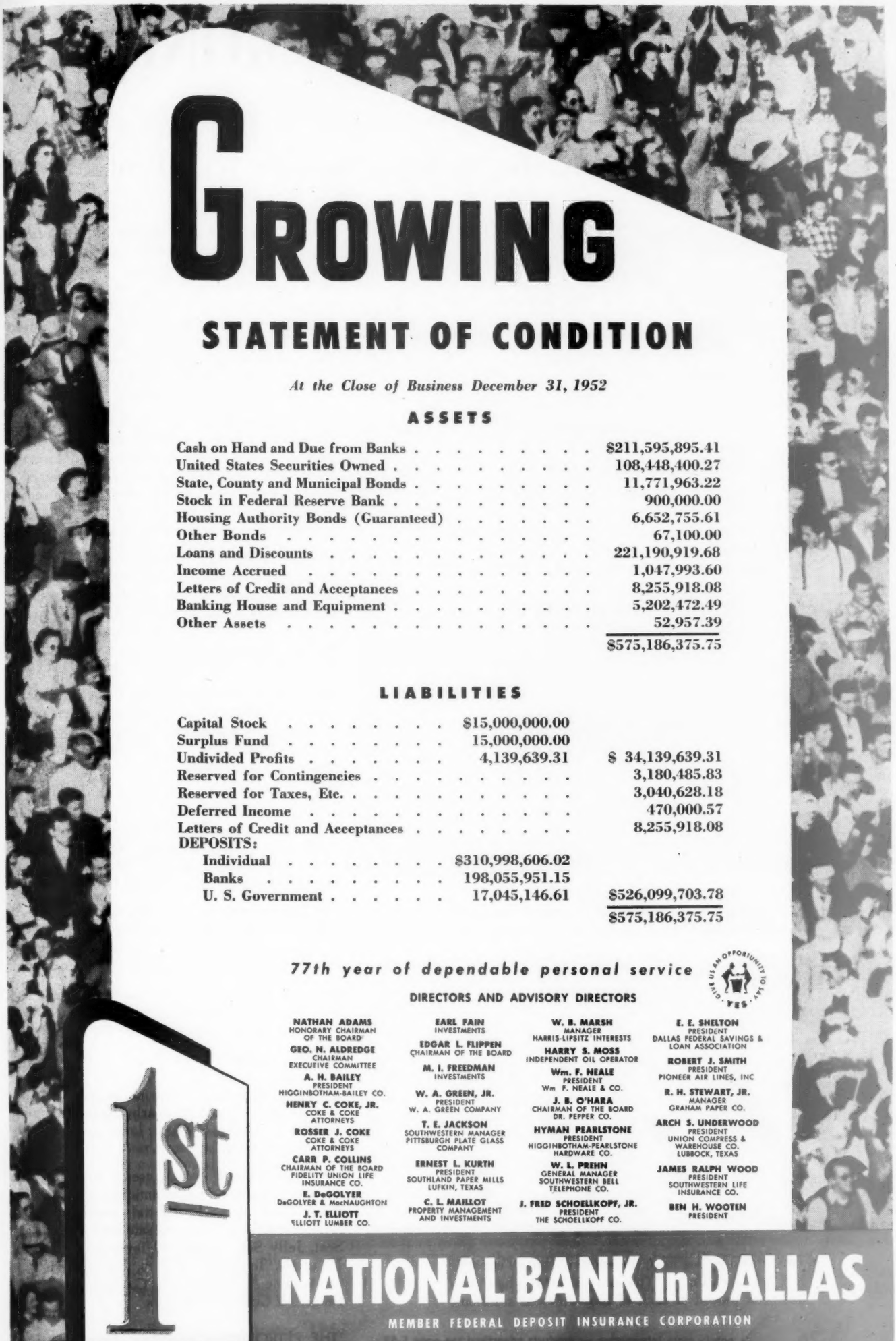
Managing Director
Steel Brothers and Company, Ltd.

Editor's note: We are pleased to grant permission to reproduce the cartoon "On the Oil Front" by Hank Roesler, in the November, 1952, issue.

☆ ☆ ☆

It took the average worker in the United States 23 minutes to earn enough money to buy a gallon of taxed gasoline in 1929. In 1939 the figure was 18 minutes. Now, even with quality much higher, it is about 10 minutes. Gasoline taxes are included in the prices on which these figures are based. The taxes have doubled since 1929.

When petroleum prices came under government controls, in mid-December 1950, the average price of major petroleum products to the consumer was 17.8 cents per gallon actually less than the average for the year 1948. It is doubted that any other industry had its prizes frozen at a point below a previous year.



GROWING

STATEMENT OF CONDITION

At the Close of Business December 31, 1952

ASSETS

Cash on Hand and Due from Banks	$211,595,895.41
United States Securities Owned	108,448,400.27
State, County and Municipal Bonds	11,771,963.22
Stock in Federal Reserve Bank	900,000.00
Housing Authority Bonds (Guaranteed)	6,652,755.61
Other Bonds	67,100.00
Loans and Discounts	221,190,919.68
Income Accrued	1,047,993.60
Letters of Credit and Acceptances	8,255,918.08
Banking House and Equipment	5,202,472.49
Other Assets	52,957.39
	$575,186,375.75

LIABILITIES

Capital Stock	$15,000,000.00	
Surplus Fund	15,000,000.00	
Undivided Profits	4,139,639.31	$ 34,139,639.31
Reserved for Contingencies		3,180,485.83
Reserved for Taxes, Etc.		3,040,628.18
Deferred Income		470,000.57
Letters of Credit and Acceptances		8,255,918.08
DEPOSITS:		
Individual	$310,998,606.02	
Banks	198,055,951.15	
U. S. Government	17,045,146.61	$526,099,703.78
		$575,186,375.75

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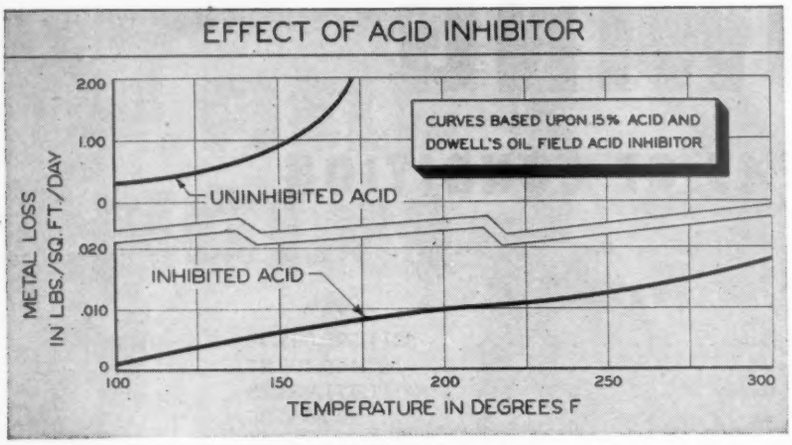
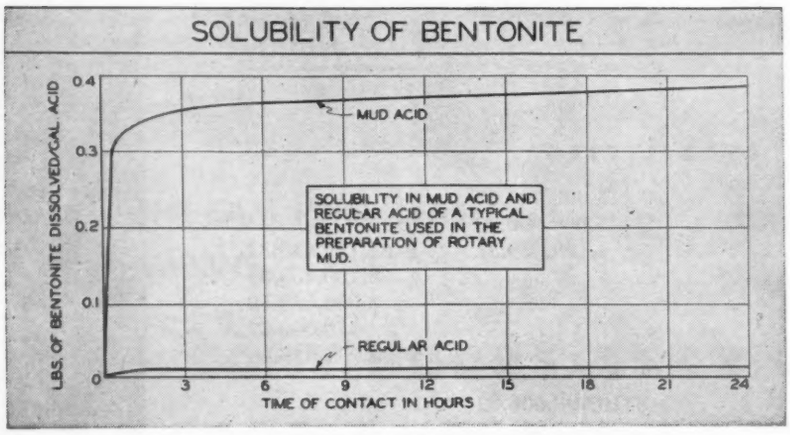
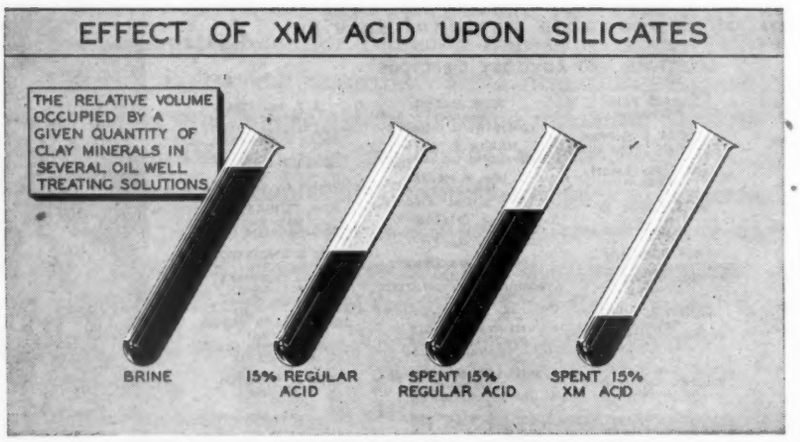


Dowell inhibitor permits high-temperature acidizing, and retards the rate of corrosion on well equipment to the point where acid damage is not at all apparent.



Ordinary commercial bentonite, such as is used in the preparation of drilling muds, is many times more soluble in Mud Acid than it is in regular acid.


EFFECT OF XM ACID UPON SILICATES
THE RELATIVE VOLUME OCCUPIED BY A GIVEN QUANTITY OF CLAY MINERALS IN SEVERAL OIL WELL TREATING SOLUTIONS
BRINE
15% REGULAR ACID
SPENT 15% REGULAR ACID
SPENT 15% XM ACID

This drawing illustrates the swelling-control effect of XM Acid on silicates. The same quantity of silicates has been placed in each of four different solutions.

Acid Corrosion? Ask for *Dowell X*—Corrosion of tubing, packers and other well equipment can become especially important in acidizing wells with high bottom hole temperatures. The Dowell inhibitor used in oil well applications reduces metal loss to approximately .01 lb. per sq. ft. per day at temperatures as high as 200°F., with less loss at lower temperatures. Some inhibitors considered highly effective will display corrosion rates at least 10 times greater.

Removal of Mud? Ask for *Dowell Mud Acid*—Dowell Mud Acid is used to remove mud sheaths and to acidize certain dolomite and sand formations. It also provides a superior method of removing mud from critical areas prior to squeeze cementing. Mud Acid is designed to dissolve bentonite and similar silicate materials.

Silicate Swelling? Ask for *Dowell XM Acid*—Certain dolomite and limestone formations contain silicates which can swell during acidizing and actually block formation pores. XM acid is designed to control such swelling. XM acid treatments have shown greater increases in production, less emulsion and easier return of the spent acid.

Faster Acid Action? Ask for *Dowell XX Acid*—This acid contains an intensifier to increase the reaction rate on dolomitic formations. Dowell XX acid is also designed to provide greater solvent action on other formations.

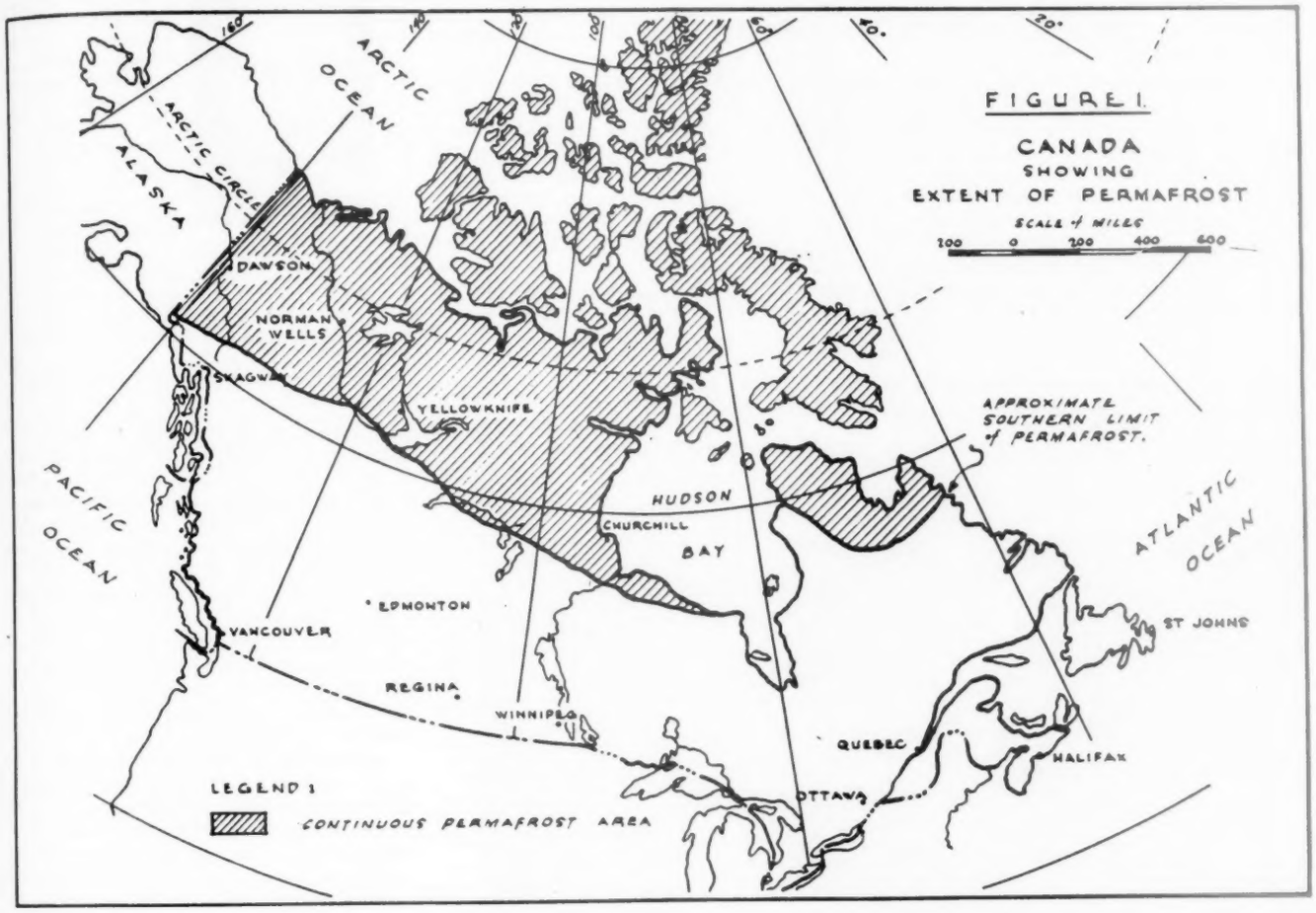
Easier Acid Injection? Ask for *Dowell XF Acid*—This acid contains a chemical to reduce surface tension, thereby increasing the penetrating and wetting abilities of the acid. Addition of the F agent aids in the return of the spent acid and permits treatment of relatively fine pores.

Oil Emulsions? Ask for *Dowell XW Acid*—An agent is added to this acid which helps to prevent the formation of emulsions and aids in the breaking of emulsions that have already been formed.

Remove "Gyp"? Ask for *Dowell XG Acid*—This acid contains a foaming agent which is helpful in removing "gyp" from tubing or the face of pay.

Tracing Agent? Ask for *Dowell XC Acid*—A special agent, used in XC acid, enables engineers to tell spent acid from formation water. Spent XC acid has been found in nearby wells. Migration to other formations higher or lower in the well has also been traced.

Other problems? Dowell uses a wide range of other treating services, chemicals, products and tools, including: Jel X materials, Sandfrac, Heavy Acid, Hot Acid, Securaloy Removal, Blanket, Soap Seal, Jelly Seal, Jelflake®, Temporary Plugging Materials, Temporary Fillers, Paraffin Solvents, Triple Zone Acidizing Tools, Compressors, Bridge Plugs, Jet Guns and Packers.



P 113

Some Northern Lights on Oil Development

A challenge — only ingenious and trained people will succeed in placing the treasures of the North on the markets of the world

RUSSELL A. HEMSTOCK

In order to sustain its civilization, Canada, and indeed the free world, must turn to new sources of materials. The soaring demands of modern ways of living for nearly every natural resource, has in general far outstripped the development of these resources. In the oil industry, pioneers, both in technology and on the frontiers, have held the line in keeping the world supplied with petroleum products. The present ever increasing needs of North America plus the need of additional reserves in the event of a world war, have encouraged oil men in the Western Hemisphere to look for new fields and new horizons. Many have turned to the great remaining frontier of North America in the search. Here, in the "land of the midnight sun," the oil men will carry out the search for and finally the development of oil resources.

The area favorable for oil exploration is a vast extension of the Alberta geosyncline stretching from the Canadian Prairies through the Northwest Territories and fanning out to a great extent along the shores of the Arctic Ocean. In the Northwest Territories alone, there is a sedimentary basin with an area greater than that of Texas. This basin holds great promise of producing millions of barrels of oil. Exploration has only been of a preliminary nature. To date there is only one producing field, that being at Norman Wells on the Mackenzie River where oil has been produced for several years.

The development of Canada's great Northland will present many trouble-

EXCLUSIVE

some problems. The climate comes first to one's mind — winters are long, dark and severe. Temperatures may drop to —60 F. Transportation is another great hurdle that must be conquered. There are no railways to provide year round entrance to the country, nor are there roads of any sort for movement within the area.

The greater part of the country is covered with swamps and bush, deterrents to travel and to local development. Because of the cold, a major part of the area remains frozen all year round. It is obvious then that the resources of the north will not be obtained easily. Let us consider a few of the difficulties.

In earlier days access to this area could only be gained by boat and barge down that highway of the north — the Mackenzie River. Now air travel has shortened world distances and brought civilization much closer to such outposts as Norman Wells and Aklavik. It is still necessary to move all heavy freight by boat or by long expensive overland routes in winter. Transportation is, therefore, a great and pressing problem.

This is a wilderness — there are no roads — much of the country is wet and swampy covered with scrub brush. Movement with normal transportation equipment is possible only at great expense in winter. It is, for all practical purposes, impossible during the summer. True, preliminary geological studies can be carried on following the rivers and using air travel — geophysical work can be done, but only with difficulty during the winter. It is also possible at great expense to move in rotary tools to drill for oil during winter months in temperatures as low as —50 F. For full scale economic development, however, one must look to new methods of moving through the country. Perhaps the answer lies in the design of entirely new vehicles, perhaps in a modification of present machines. In any event, there must be provided reliable and reasonable year round transportation to ensure that development of new fields will not be too costly to allow their oil to compete in world markets.

A discussion of transportation for the north would not be complete if mention were not made of the present use of the helicopter. This relatively new development in flying has already proved itself in exploratory work. In serving two or three surface parties the helicopter has made possible rapid and efficient exploratory coverage over all sorts of terrain. In the 1952 season several helicopters were used in the north by oil companies and by government geological crews. Reports of their serviceability and efficiency are good. A tool such as this shows its real value in speeding up the discovery and development of the mineral wealth of a new land.

It has been mentioned that much of the Canadian north is wet and swampy. The local term is muskeg, a bottomless bog of water, silt, and vegetation remnants. The ground surface may be hummocky area covered with scrub brush or in some areas the bush may be fairly heavy. Travel over this type of land is impossible unless the ground is frozen hard enough to carry the vehicles that are in use today. Problems of this kind are not new to the oil industry, but development is more difficult and costly.

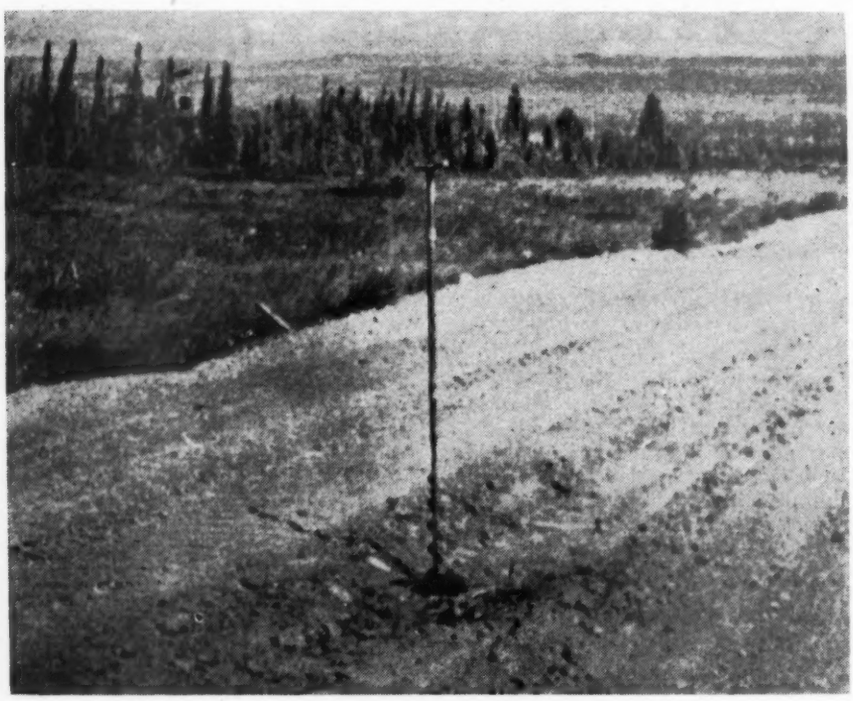
A new and troublesome phenomena will also present itself to oil men in the North. It is permafrost. This term relates to a thickness of soil or other superficial deposit, or even of bed-rock at variable depths beneath the surface, in which a temperature below freezing has continually existed for a long time. The extent of this area is indicated in Fig. 1. Roughly one-fifth of the entire land surface of the world is underlain

The Author

Russell A. Hemstock is a district engineer for Imperial Oil, Ltd., in the Redwater, Canada, office. A graduate of the University of Alberta, where he obtained both his BS and MS degrees, Hemstock joined Imperial Oil on the Canol project at Norman Wells in 1943, remaining there in various positions until 1947. In early 1948, he joined Imperial Oil's engineering department in the Leduc field in Alberta, transferring to Redwater in 1951.

FIG. 2. Subgrade of a road is shown here. Moss and scrub from sides of road have been pushed in to form an insulating base.

FIG. 3. This is a finished road, grade has been hauled in to cover the subgrade.



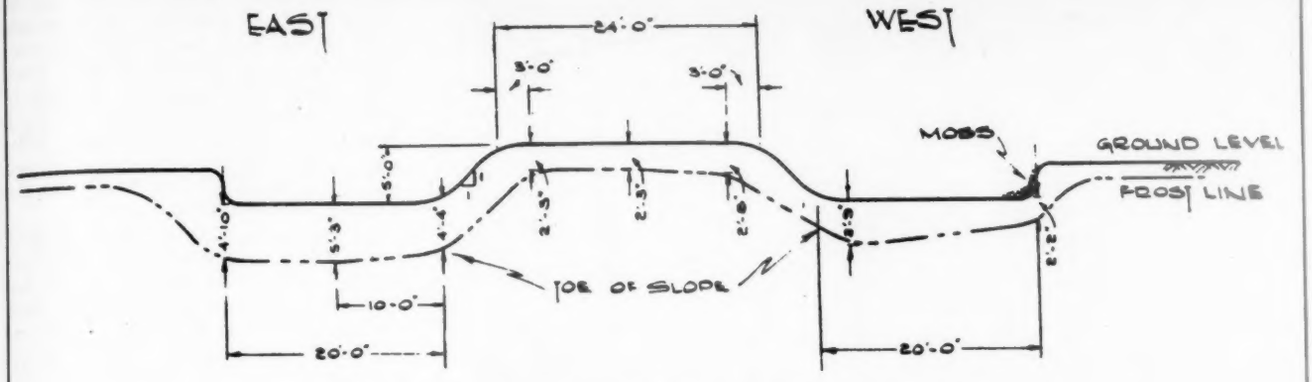


FIG. 4. Resulting desirable frost line in the roadbed is indicated here.

by permafrost. It is agreed that permafrost first appeared in the Pleistocene or Ice Age as a result of abnormal ground freezing.

Thickness of permafrost in North America varies according to location, from a few feet in the south to over 1200 ft in the extreme north. At Norman Wells, a thickness of 140 to 200 ft has been recorded. Drilling in Alaska has indicated permafrost to a depth of about 1200 ft.

Typically, in permafrost areas, there is at the surface an "active" layer, one to five feet thick, in which the soil is subject to seasonal freeze and thaw, and from which such troubles as frost heaves, frost mounds, and icings originate. Below this one finds permafrost to various depths, succeeded by normal unfrozen material showing the usual temperature gradient. It is in such surroundings that permafrost will first affect the operations of those seeking oil. In the summer, the first trip with tractors or other equipment will be made with little trouble but, as the moss and vegetation is disturbed, the ice and soil below thaws out, resulting in a hopeless sea of mud.

Road building and airport construction are the first requisites of any program for development of oil resources in remote northern areas. The presence of permafrost requires that special methods of construction be employed if satisfactory results are to be obtained. At Norman Wells, experience showed that the best results were obtained when moss and scrub from both sides of the road were pushed over undisturbed original moss to the center of the graded roadbed. This material was then packed and over it was placed a filled subgrade, either from the ditches or from borrow pits (see Figs. 2, 3, and 4). This method is essentially the same as outlined by Mueller;* it allows for good drainage, and also causes a rise in the permafrost level in the road-bed. In muskeg areas, all stripping of moss and vegetation and subsequent piling in the road-bed should be done in the spring, after the snow is gone, so that machinery can move easily and efficiently on the still frozen ground. Although this sort of construction has been used for airports in the North, it is generally much cheaper to locate the airport on a suitable area of high, dry ground, even though this may be some distance away.

In planning construction of buildings in permafrost areas there are two general methods that may be used. These are known as the "active" and the "passive" methods. Where permafrost is thin and sporadic and ground temperatures are above 29.5 deg, the frost generally should be eliminated by thawing before construction is begun. This is the "active" method. Where ground temperatures are below 25 F, the frozen ground conditions are left undisturbed, or more insulation is added so that any new thermal regime will not cause thawing of the ground; this is the "passive" method. Where ground temperatures are between those mentioned, either method may be employed. The active method, however, should be used only where the properties of the ground in the thawed state are such that satisfactory foundations can be designated for the soil in its new state. Elimination of permafrost is not generally feasible if it persists to depths of over 40 ft.

The experience of the Russians in Siberia, and lately of ourselves in the Northwest Territories and Yukon, emphasize the fact that an extensive preliminary investigation of permafrost is most important if long-range projects are to be successfully established in these far northern districts. In normal construction in the south, it has often been found that a lack of preliminary investigation has resulted in great losses of time and money. Unless proper precautions are taken, these losses will be many times greater in the north, where permafrost prevails.

Three main factors must be checked

FIG. 5. This photograph shows steel pilings under a building. The moss surface has been left in place to help maintain the frost level.

*Muller, S. W., Permafrost; J. W. Edwards, Inc., Ann Arbor, Michigan.

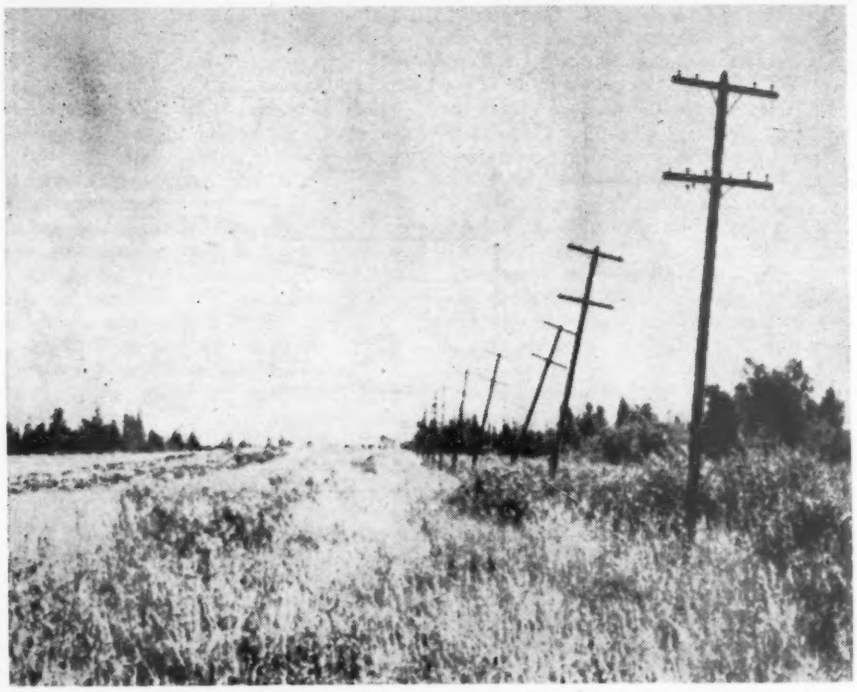


FIG. 6. Failure of this power line resulted when poles were heaved out of the ground by frost action after only 2 seasons.

before construction of buildings is commenced in new locations. They are:

1. Texture and structure of the ground.
2. Temperature of ground and air.
3. Hydrology of the ground.

A study of these factors, together with a knowledge of the requirements of the structures involved, will enable the engineer to choose the most practical foundations. Commonly, footings for light, temporary buildings in the North are simply log or timber pads, or posts on pads. Larger, more permanent, structures are best founded on piles properly anchored deep in permafrost, with the original ground surface well insulated to prevent thawing. Piles may be wood, steel, or concrete. As a general rule, it has been found that, in order to provide for proper anchorage of piles, they should be driven to a depth in permafrost equal to 2½ times the depth of the "active" layer. Generally, holes are steamjetted into the frozen ground and the piles are driven firmly into the thawed holes (see Fig. 5).

To date, pipe lines in nearly all these far northern operations have been laid on the surface. The 660-mile Canol line of the last war was on the surface from Norman Wells to Whitehorse. The operation of these surface lines is so unsatisfactory that it is recommended that all future lines be buried. As the "active" layer is seasonable and frozen ground cannot be ditched, lines should be covered wherever possible by pushing moss over them to protect them from the great variations in temperature and the extreme cold in winter.

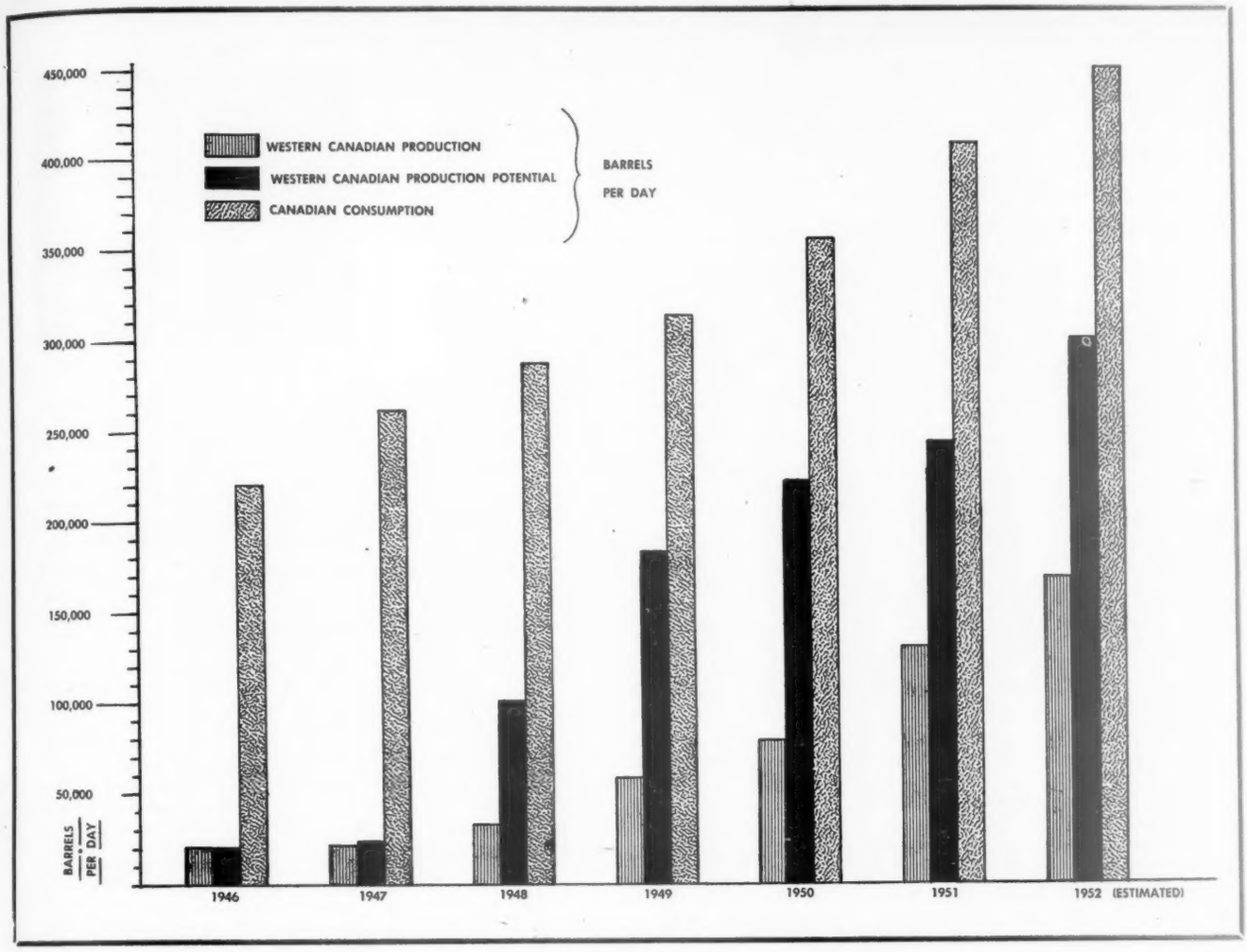
The construction of water and sewer lines to service northern communities also presents a unique problem (see Fig. 6). If these lines are ditched to grade, some source of heat must be provided to prevent them from freezing. The cost of installations of this sort is further increased by the necessity of ditching frozen ground. Another method that has found favor is to install all lines in a well-insulated box resting on piles above ground. This method allows for easy repair of lines and is flexible and relatively cheap. Steam from a central heating plant may be used as a source of heat.

The problems discussed in this paper are only a few of those which will confront the oil operator in the North. He will not, however, be alone in his fight to overcome these problems. Such groups as the National Research Council, Ottawa, the Department of Naval Research in Washington, and the Arctic Institute of North America have already carried out extensive studies on northern development. The results of these studies, when combined with sound engineering in the field, will clear away many of the technical difficulties.

What may well be the key to the whole development of the North is the people who will do the job. The ingenuity and drive of the American people have conquered great problems, and the movement North will not be the least of these. Life there will be new and difficult, and somewhat cut off from the rest of the world. In summer the sun never sets and in the winter the continual darkness will be oppressive. A few months in summer may be warm and pleasant but for much of the year, cold is a hardship. To keep trained, experienced personnel, and to minimize labor turnover, management must realize their responsibility in choosing men and in keeping them happy. Only by every effort to minimize discomfort and look after each man's body and soul will it be possible to maintain the best possible human organization. Only the best will succeed in placing the treasures of the north on the markets of the world.

* * *

Edmonton is the "Gateway to the North". Photo shows Edmonton Legislative building, Province of Alberta. Feverish oil activity centered around the city when the nearby Imperial Leduc discovery well come in as an oil producer in February 1947.



CANADA'S EXPANDING OIL POTENTIAL

Rapidly growing reserves and resolving of marketing outlets bring prospect of overtaking Mexican production in 1953 to establish Canada as the third largest producing country in the Western Hemisphere

DONN C. LANGFORD and JOE U. STREETER

THE dynamic development of the Western Canadian plains during the last six years as a major source of crude oil has arrested the attention of operators throughout the world and has given rise to much speculation as to its effect on the international economy. Canada's history in oil production is nearing its First Centenary but even the entry of Western Canada almost 40 years ago as a proved area did little more than indicate the potential that awaited discovery.

Today, the Western sedimentary basin represents more than 99 per cent of Canada's actual production, the other producing provinces being Ontario and New Brunswick. The producing areas within the basin are Alberta, Saskatchewan, Manitoba, and the North West Territories, although oil has been discovered in northeastern British Columbia and exploration in the Yukon is planned. Alberta is dominant in all phases of the activity, producing approximately 96 per cent of Canada's oil in 1952 and ranking in a somewhat similar position as regard to proved reserves.

EXCLUSIVE

Western Canadian Reserves

The success attained in the discovery of Leduc in 1947 followed by Redwater in 1948 brought Western Canada into quick prominence and led to a great influx of operating companies and capital —obviously one of the largest movements to a new area the industry had ever experienced. Many factors entered into this decisive action, such as a political and financial climate favorable to exploration and development, accessibility of country particularly on the southern plains, discovery of oil bearing reef formations indicative of large reser-

voir characteristics combined with multiple zone possibilities, vastness of the potential area and, by no means least, possibility of developing adequate and retained markets at reasonable field prices in the foreseeable future. The prospect of a new Continental source of crude and its defense implications was not overlooked.

The resulting exploration activity has been little short of phenominal and each year's records are being overrun by new and more spectacular achievements. Discoveries of oil and gas have been maintained at an annually increasing rate from 17 in 1947 to 90 in 1951 for a total in that period of 277, and indications are that 1952 will turn in an estimated 105 new strikes. Of the latter, some 55 are oil discoveries compared with 33 in 1951.

It is axiomatic that the discovery rate increases in broad relation to the wildcat footage drilled in any geologically favorable area, but the behavior of reserve additions is generally erratic, at least until such time as the exploration activity has reached an extensive scale. The existence of major fields in the Canadian inland plains and the irregularity of their discovery have been contributing factors to the comparatively wide variations evident in the first column of Table 1. The record of these fields commenced with Turner Valley many years ago, followed by Leduc-Woodbend, Redwater (the largest of all with initial recoverable reserves now estimated at 744,000,000 bbl) and Golden Spike in 1949. Important new fields continued to be found thereafter, but none was of major significance until early in 1952 the Bonnie Glen strike in the Devonian D3 reef consisting of nearly 700 ft of wet gas and oil column and subsequent development indicated reserves of 200,000,000 bbl and is leading to a concentrated search into virgin country.

The realization of sizable proved reserves over a period of a few short years is impressive especially when it is appreciated that in 1952, the year of greatest activity, less than 800 wildcats were drilled in the 195,000,000 acres under exploration.

Markets — Actual and Potential

Six years ago the Canadian Prairies largely depended on imported crude and petroleum products. By 1951, self-sufficiency was accomplished in this natural marketing area, which, incidentally, necessitated a threefold expansion of refining capacity.

The next market toward which the producers looked was that of Ontario represented particularly by the refinery center of Sarnia. The barrier of prohibitive railway transportation costs could only be overcome by the building of a pipe line and late in 1950 the Interprovincial from Edmonton to Superior, Wisconsin, was completed. The following year the pipe line served intermediate refineries, initiated the export of crude to the United States and, in conjunction with a growing tanker fleet, penetrated the Ontario market. The throughput to Superior was almost doubled to an estimated 60,000 bbl daily in 1952. A further expansion program being carried out will shortly raise the input capacity to 155,000 bbl daily and permit a peak throughput of approximately 100,000 bbl daily.

Extension of the eastern pipe line from Superior to Sarnia is now receiving consideration. From this, it may be postulated that a large-scale duplication of the original Interprovincial line is a probability of the future, combined with possible long-range provision being planned for developments in the Williston Basin. Such a project would eliminate the four-to-five month interruption of Sarnia deliveries owing to the closing of navigation on the Great Lakes during winter months. Allocation of the 30-in. pipe has been made and, as planned, the line would have an initial capacity of 85,000 bbl daily with an ultimate daily capacity of more than 300,000 bbl.

Of major importance to marketing plans is construction of the Trans Mountain oil pipe line from Edmonton to Vancouver, B. C., now well in hand with completion scheduled for August 1953. Initially, the line will be able to handle up to 120,000 bbl daily and is designed for an ultimate throughput in excess of 200,000 bbl per day. British Columbia, entirely supplied by imports until recent months, consumes more than 50,000 bbl daily and refinery expansion now building or planned will bring that province's total daily capacity to 48,350 bbl. In the initial phase of the pipe line operation at an indicated rate of 75,000 bbl daily it is anticipated that crude oil deliveries to the West Coast will serve local refineries, and also provide a supply for offshore markets and to meet the current shortage in California.

The extensive marketing area of the

The Authors

J. U. Streeter D. C. Langford

Donn C. Langford is manager of the petroleum and natural gas division of The Canadian Bank of Commerce at Calgary, Alberta. A native westerner he completed his education at Toronto where he joined the bank 25 years ago. During his career, Langford has been identified with various phases of commercial banking, moving to Calgary concurrent with the acceleration in oil developments. He was instrumental in setting up the division, an innovation in Canadian banking circles.

Joe U. Streeter is petroleum advisor to the petroleum and natural gas division of The Canadian Bank of Commerce. After receiving a BS degree in geology at the University of Alberta in Edmonton, he worked on surface exploration in Saskatchewan and Alberta and served as an exploration geologist in the gold area of Yellowknife, Northwest Territories. Following the Leduc discovery he obtained diversified experience as a sub-surface geologist on wildcat and field development wells in Alberta. Streeter later received a Masters degree in business administration at the University of Chicago and joined the bank at the inception of the division some three years ago.

Drilling operations in Western Canada, from where more than 99 per cent of the country's production is obtained.

A. D. Dunlap, Vice President in charge of Canadian Operations, has been with IX for 20 years. After his graduation from Rice Institute he started in as a helper on a seismograph crew. Since then he has worked his way up . . . helper to shooter . . . to observer . . . to computer . . . to party chief, before his promotion to Vice President. His long continuous service with Independent Exploration Company typifies the skill and field work knowledge that IX's clients find valuable.

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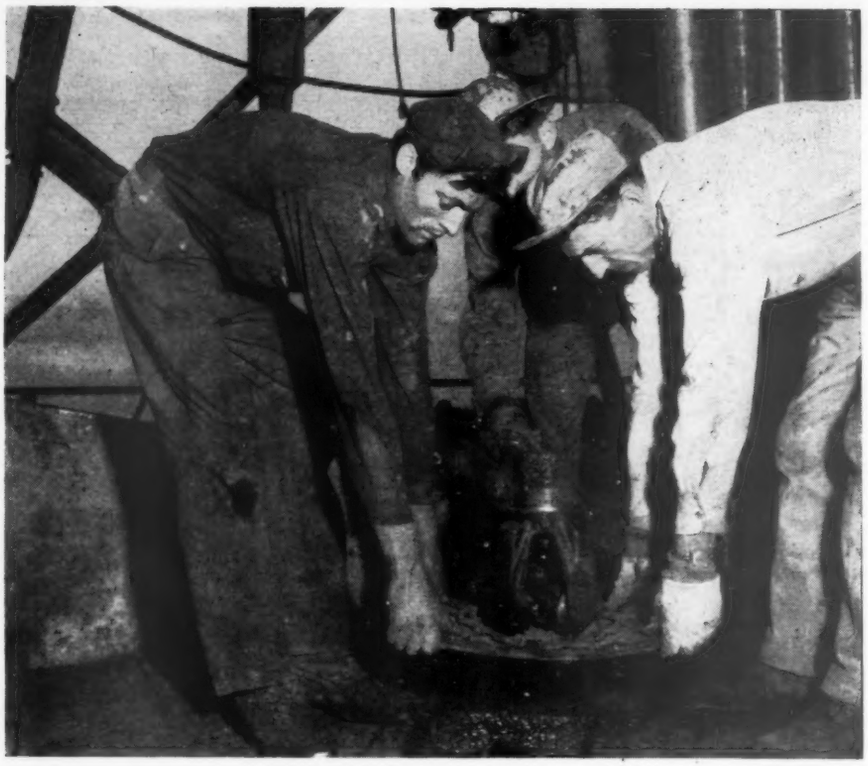


1952 will turn in an estimated 105 new strikes, of which some 55 are oil discoveries compared with 33 for 1951.

Pacific Northwest states is almost wholly deficient in refining facilities. As the first step receptive to Canadian crude, announcement has been made by General Petroleum Corporation to construct a refinery of 35,000 bbl daily capacity near Seattle with completion forecast by autumn of 1954. An extension of the Trans Mountain to connect with the plant will be built.

Canada's ultimate markets in the United States will mainly center in the Pacific Northwest and the area around the head of the Great Lakes. The trade agreement recently concluded between United States and Venezuela reducing the duty to 10½ cents on lighter gravity crudes regardless of quantity imported will prove of great benefit to Western Canadian producers.

From the accompanying chart it is apparent that Canadian consumption of petroleum products is far from static. In fact, it has more than doubled since the close of World War II and is growing twice as fast as in United States. Despite increased domestic production, imports of crude and products rose from 70,600,000 bbl in 1946 to 106,700,000 bbl in 1951 and the trend is believed to have continued through 1952, but may be expected to show a reversal in 1953 through substantially enlarged production. Per capita demand now stands at 11.5 bbl per annum and is forecast at 13 bbl by 1955. In meeting the rising prairie demand and by means of surmounting the obstacles of distance and terrain to serve new and broadened markets, Western Canadian operators will raise the level of production in 1953 to a probable peak of 300,000 bbl daily by the fall, concurrent with the opening of the Trans Mountain line. The average daily production rate for this year may be expected in the neighborhood of 225,000 bbl, an increase of one-third or more over that of 1952. Further substantial gains in 1954 may be anticipated when the full impact of the westward and eastward movements of oil to consolidated markets is realized.

WESTERN CANADA

(Thousands of Barrels)

	New reserves added during year	Net increase after deducting production	Estimated proved reserves at end of year	Ratio of reserves to year's production
1946	—	—	72,000	9.69
1947	85,538	78,000	150,000	19.90
1948	428,688	416,600	566,600	46.87
1949	487,425	466,400	1,033,000	49.13
1950	245,776	217,000	1,250,000	43.44
1951	174,479	126,000	1,376,600	28.75
1952 (est)	385,176	323,400	1,700,000	27.52

(Excludes any estimate of the reserves of the Athabasca Oil Sands)

Productive Capacity and Actual Production

In Alberta, the Petroleum and Natural Gas Conservation Board provides a maximum permissible rate (MPR) for the production of light and medium gravity crude for most of the fields on a formula basis reassessed at four-month intervals. In effect, this may be calculated somewhere close to 7 per cent per year of those recoverable reserves in that province although the conditions of marketing heavy crude in Alberta and Saskatchewan along with the limitations of demand in the North West Territories tend to reduce the over-all potential figure for Western Canada. This compares with an average rate of actual production in the United States of between 7 and 8 per cent during recent years. The fact that production in Western Canada is currently little more than half of the existing production potential (see chart) may be looked upon as normal in a new, developing area dependent on the construction of transportation and refining facilities.

With the buoyant outlook for markets, some concern may be felt that the potential might be overtaken by demand. This seems unlikely although the gap will probably be reduced with the maturing of the industry. The average annual net increase in reserves during the past six years was slightly more than 270,000,000 bbl, far in excess of actual production and permitting a steady gain in additional daily production potential. Increased production which tends to reduce the yearly gain will likely be offset, as far as may be foreseen, by a higher rate of discovery resulting from accelerated exploration activity. In the event of an oil shortage under emergency conditions or other circumstances, an increase in the maximum efficiency rate equivalent to 1 per cent applied to present reserves would raise the productive capacity by nearly 50,000 bbl daily.

Canada, second only to United States on a per capita basis in the utilization of energy, is penetrating new economic frontiers. A quarter of these sources of energy is derived from petroleum and, in approaching self-sufficiency in the supply of this valuable natural resource, this country is providing a much needed supplement to the reserves of the North American Continent. ★ ★ ★

CANADA LOOKS AHEAD

A preview of things to come in Canadian oil and gas

FLOYD K. BEACH

In 1941 Canada's population was about 11,500,000 and they consumed a little over 5 bbl of petroleum products per capita and the major part of it was imported, largely from our good neighbor to the south. From early in 1942 to the end of the war gasoline was rationed, with some restraint on the upward trend of consumption, but with the end of rationing the curve of consumption rose.

In 1951 our population had risen to 14,000,000 and the per capita consumption had risen to 9 bbl and the total consumption was more than double that of 1941, amounting to 126,000,000 bbl.

Domestic production in 1941, mostly from Alberta, was about 10,000,000 bbl. That declined until the discoveries of Leduc in 1947 and Redwater the following year, but in 1951 Canada produced over 48,000,000 bbl and could have produced more but for the limitation of transportation facilities.*

Reserves of oil in 1941 appeared to be of the order of 100,000,000 bbl, neglecting the Athabaska tar sands and the heavy black oil in the Lloydminster district. A recent estimate by a reputable firm of consultants in Calgary puts present reserves in western Canada at 1.9 billion barrels. At present rates of consumption this would supply all Canadian demand, if transportation facilities allowed, for 15 years.

The opening of navigation on the great lakes in 1951 saw the first deliveries of western oil to Ontario, and by midsummer of 1952 the eastward flow reached about 100,000 bbl daily. During the winter season when navigation on the great lakes is stopped, deliveries must be curtailed. Although considerable storage has been provided both at Edmonton and at Superior, Wisconsin, as soon as that storage is filled, the only winter outlet is to prairie refineries, and their winter demand is only a fraction of what they require in summer.

Now where is Canada's oil and gas industry heading?

It is quite hopeless to consider trying to supply Montreal's big demand with western oil through pipe line to Superior and lake tankers, even if canal facilities around Niagara were adequate, in competition with ocean tankers to Portland, Maine, and the dual pipe lines from Portland to Montreal under present conditions of world supply. Much less could western oil compete at the ocean port of Halifax. Part of the answer to Alberta's marketing problem lies in moving oil to the Pacific coast.

In 1951, British Columbia used an average of 43,000 bbl daily, most of it coming from California. About half the British Columbia consumption was refined there and half imported as refined products — a sizable part being bunker fuel for fueling shipping. After careful studies of the marketing situation, reserves and sources of supply, six major oil companies sponsored Trans Mountain Oil Pipe Line Company. It now appears that this 24-in. line 711 miles long from Edmonton to Vancouver will be in operation by August 1953. Initially three pump stations will provide a throughput capacity of 120,000 bbl daily. Addition of two more pump stations and a booster station will increase the capacity to 200,000 bbl daily.

Even before the new line was well under way, it became necessary to make rail shipments to Vancouver. General Petroleum Corporation has announced plans for a refinery at Ferndale, Washington, with a planned daily throughput of 35,000 bbl, and an extension of 18 miles from Trans Mountain will supply it. New refining capacity at Vancouver is expected to raise British Columbia throughput capacity to 45,000 or 46,000 bbl daily by the time the line is finished. This leaves a potential of around 40,000 bbl daily for export from the Vancouver terminal and the sponsors apparently feel that it will be taken up shortly.

*A recent press statement is that International Pipe Line Company is practically set to extend its line from Superior to Sarnia.

The Author

Floyd K. Beach has been connected with the oil and gas industry in Alberta for 25 years. He is practicing as a consultant and is Western field editor for *Canadian Oil and Gas Industries*, published in Gardenvale, Quebec. He is a member of the Engineering Institute of Canada, Professional Engineers of Alberta, Canadian Institute of Mining and Metallurgy, AAPG, Alberta Society of Petroleum Geologists. He was graduated from Traverse City high school and attended Albion College.

Growth in Canada's Domestic Demand

The figures given at the beginning suggest that over the past decade the per capita demand has had an annual increment of between 5 and 6 per cent. Where has this increase arisen, and will it continue?

Part of the increase has come from a change-over from coal to oil fired locomotive boilers and diesel locomotives. That change-over is by no means complete. Some added demand will come with increase in railway traffic. Another very large increase in demand has come with mechanization of farm equipment. The horse has been replaced by the tractor and it appears that saturation of that demand is near in so far as existing farms are concerned. Most of the land suitable for agriculture is now farmed. With extensions to irrigation some additional agricultural population could be expected, and one large irrigation scheme is under construction. It is in southern Alberta and as one goes north the season shortens with accompanying risk to irrigated crops.

Political speakers talk of a population in Canada of 35,000,000 in the foreseeable future. Certainly Canada could feed that number or more but the problem of employing them may be great.

If one supposes an annual increment of 2 per cent over the next decade, in line with the past decade, Canada will have some 17 1/3 million people in 1961. If the per capita consumption of petroleum products follows the pattern of the past decade, the demand will reach 15½ bbl, or 270,000,000 bbl annually for the country, and the present reserve will be gone before 1961 if the exports and imports balance each other.

Oil Finding

In 1941 Alberta drilled 86 wells, of which 20 were exploratory, and the other western provinces saw little drilling. In 1951 Alberta alone drilled nearly 1200 wells of which 300 were wildcats, and another 100 were either outposts or somewhat more risky. Saskatchewan,

EXCLUSIVE

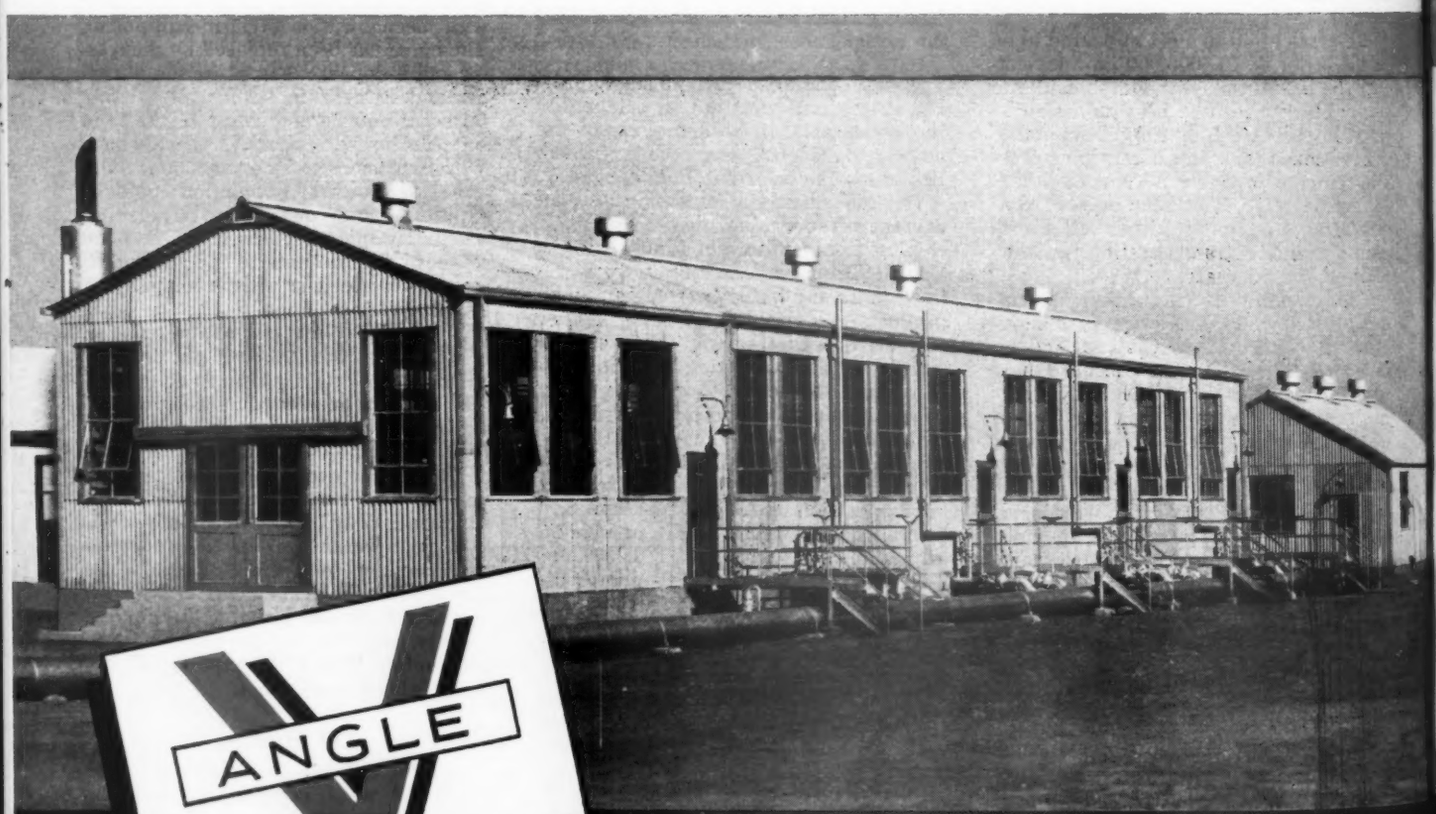
COOPER-BESSEMER V-ANGLES ON THE JOB

Conserving Gas and Dollars

AT LONE STAR GAS COMPANY'S KATIE PLANT

THE answer to efficient, low-cost compressor service at Lone Star Gas Company's gasoline extraction plant in the Katie Field is this 2,560-horsepower line-up of Cooper-Bessemer V-angles. These units, 3 GMX's and a GMV, compress casinghead and low pressure distillate gas from about 60 psi suction to 415 psi discharge, for delivery to the absorber.

Of particular interest, the engines have automatic speed control and drive compressor cylinders selected for a wide range of operation without the use of unloading equipment. Add to this the fact that *every crankthrow*, all down the line, drives a compressor cylinder. Here's an economical, easy-to-maintain setup that makes the most of Cooper-Bessemer V-angle compactness.



Compressors

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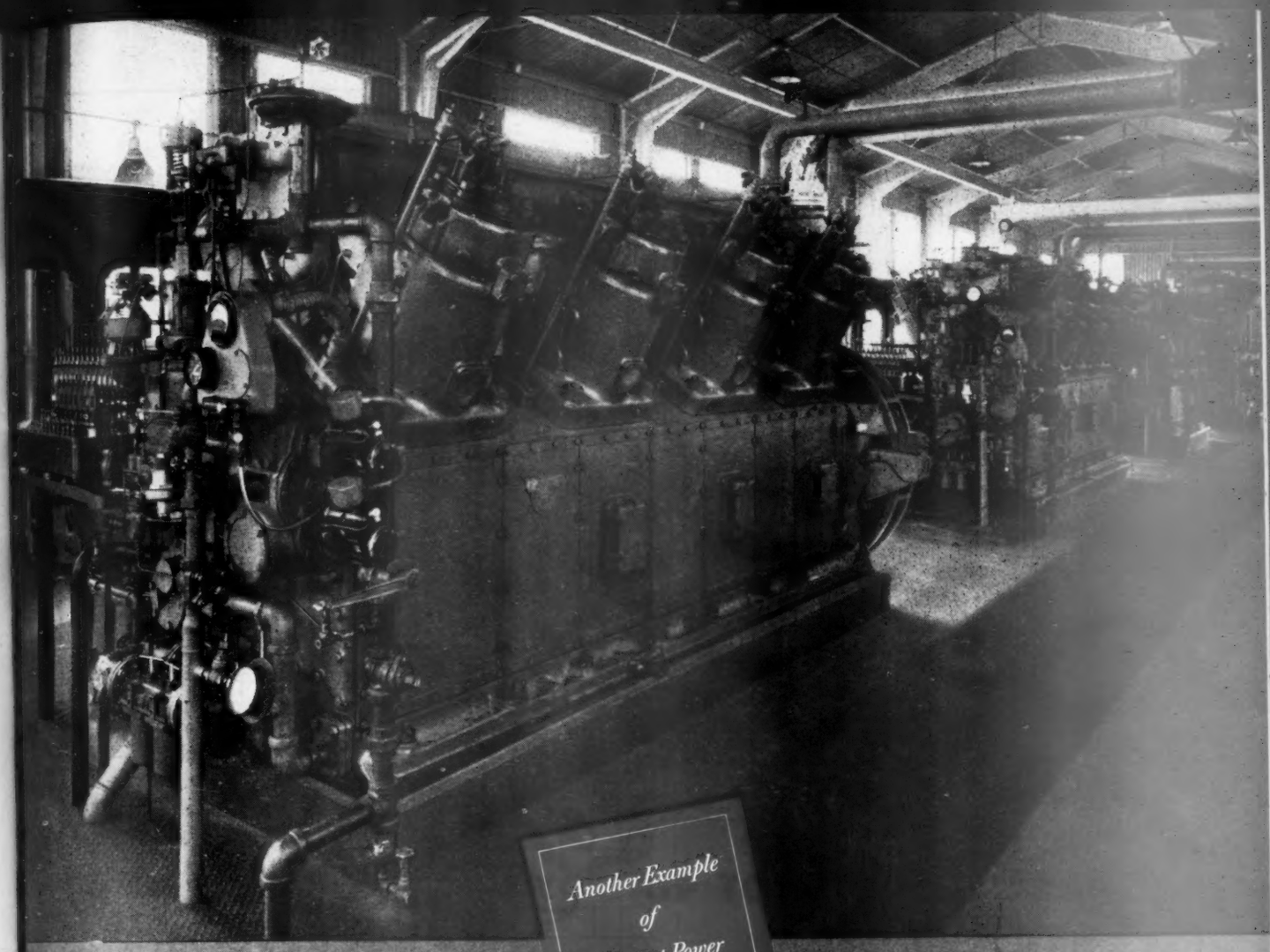
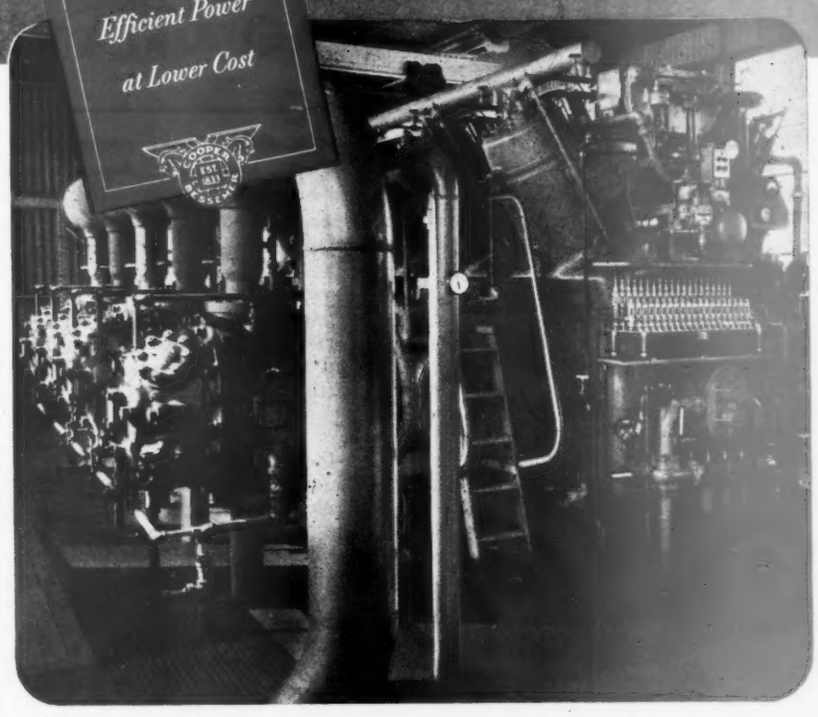
San Francisco, Cal. Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle, Wash.



Another Example of Efficient Power at Lower Cost



ABOVE: This line of Cooper-Bessemer V-angles in Lone Star Gas Company's Katie Plant consists of two 440 hp GMX-8 units, a 330 hp GMX-6 and a 1,350 hp GMV-10.

RIGHT: Note in this close-up of the GMV-10 that each of the 5 engine crankthrows drives a compressor cylinder — a space-saving V-angle feature.

LEFT: Compressor building at Lone Star Gas Company's Katie Field Plant housing 2,560 Cooper-Bessemer V-angle compressor horsepower.

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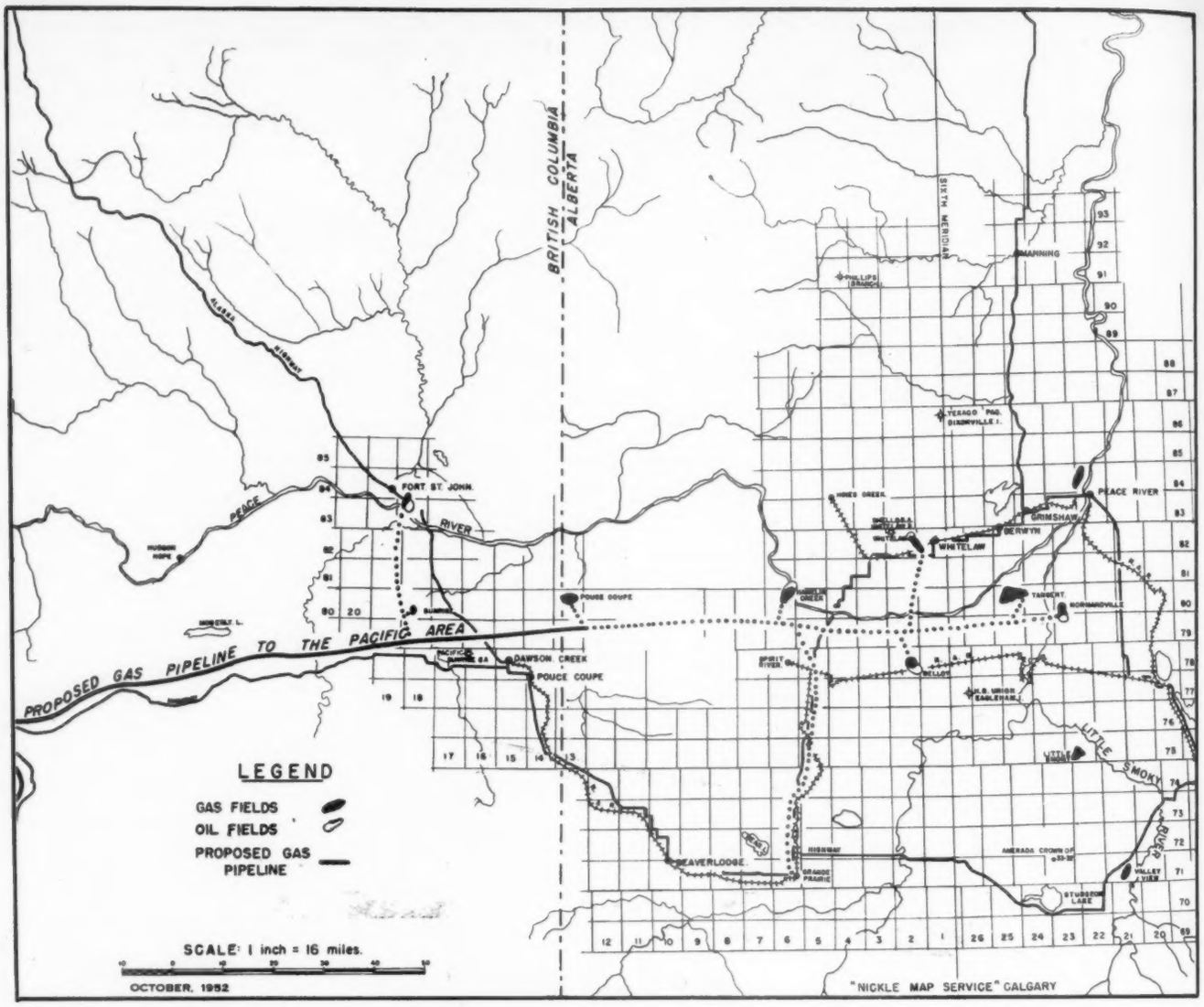

Map shows Peace River Area. The region is divided between the provinces of British Columbia and Alberta. Important gas finds occurred in 1952, and 1953 may see active development. The Dominion Government has reported on the available gas reserves in the area with consequent approval by the Department of Transport. A gas transmission line to the Pacific Area is proposed tentatively.

The discovery of a reef formation in the Peace River Area last year forms a link between the large reefs near Edmonton, and the one at Norman Wells, which is almost on the Arctic circle.

Manitoba, and British Columbia drilled 63 exploratory wells plus development wells the number of which is not available at the moment. Many discoveries have been made, though none of them so spectacular as Leduc and Redwater. Some of the Saskatchewan and Manitoba finds are in the Williston Basin and Saskatchewan's Coleville field with heavy black oil from the Banff sand of lower Mississippian age may or may not be called Williston Basin. Alberta drilling has found numerous reefs and a string of them, apparently separated from each other off to the southwest of Leduc, appear to have quite large aggregate reserves. The Viking sand production from Joseph Lake through Armena and Camrose is relatively shallow, of good quality and quantity. More sand discoveries can be expected. Just recently one well in the Peace River country found a reef. Until follow-up drilling evaluates it, the industry cannot know how much reserve has been found, but all operators feel that its discovery is most important, for it forms a link between the big reefs near Edmonton and the reef at Norman Wells, almost on the Arctic circle.

Natural Gas

Incidental to the exploration for oil, many gas discoveries have been found. Early in 1952 the Alberta Petroleum and Natural Gas Conservation Board reported reserves of 6.8 trillion cubic feet, and their estimates are most conservative. They added that, "in drilling of 400-500, wildcat wells per year the Province of Alberta can safely anticipate the development of further established reserves at an average rate of at least 1 trillion cubic feet per year for at least 8-10 years."

One company has permission from them to export a limited quantity of gas from a limited area in Alberta in the Peace River country. That company has found material reserves in adjacent British Columbia, and the Dominion Government has reported on the available reserves with consequent approval by the Department of Transport. The company now awaits approval of the U. S. Federal Power Commission and contracts with gas distributing companies in the Pacific northwest states before starting a transmission pipe line.

Others have projects to pipe gas eastward. Ontario and western Quebec are in great need of additional fuel to relieve the need of importing coal and one proposal contemplates an all Canadian gas line from Alberta to Montreal, serving intermediate points on the way.

Continental Defense

The oil pipe line to Vancouver, with latent possibility of increasing its capacity, is of interest to all nations on the continent from a defense standpoint. While all wish for peace, the possibility of supplying defense forces in time of war with 80,000 or 100,000 bbl daily, over and above peacetime needs, should warm the hearts of every loyal American toward his northern neighbor. * *

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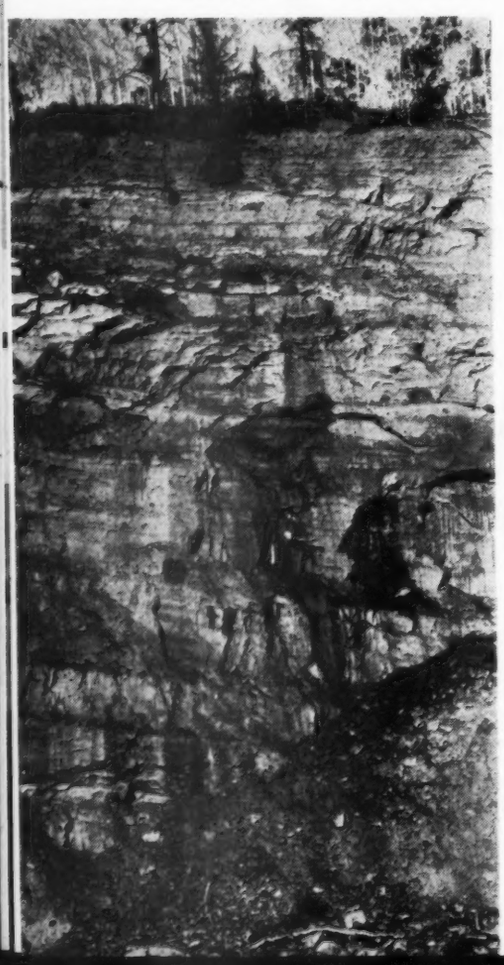
FIG. 1. Oil sand cutbanks on Athabasca River with limestone showing just above river level.

Alberta Oil Sands

World's largest oil reserve lies at shallow depth yet large commercial production has not materialized

D. S. PASTERNACK

FIG. 2. Close-up of an oil sand cutbank.



THE enormous deposits of bituminous sands in northern Alberta represent one of the world's great oil reserves. On extraction, the bituminous sands yield bitumen, a black-looking material having the consistency of molasses. Frequently the bituminous sands were called "tar sands" and the bitumen was called "tar" as these terms were simpler and indicated to the layman the nature of the material. Since retorting of the bitumen yields over 80 per cent by volume of a fluid oil, which is similar to the petroleum obtained from oil wells, the tendency now is to refer to the bituminous sands as oil sands and to the bitumen as oil. This trend will be followed in this paper.

Oil Sand Deposit

Location. Major outcroppings of the oil sands have been topographically mapped over an area of approximately 1260 square miles.[8] These outcroppings —typical ones are shown in Figs. 1 and 2—occur along the banks of the Athabasca River and tributary streams, from about 40 miles south of McMurray northward for 115 miles.

Stratigraphy. The oil sands comprise a portion of the McMurray formation, which is a Lower Cretaceous sediment resting unconformably on the Waterways formation of Upper Devonian limestones.[7] The sedimentation in the McMurray formation is represented by massive and cross-bedded unconsolidated sandstones—in places conglomeratic — interstratified with clay and shales. Drilling and coring of the oil sands has shown that clay beds are commonly present in all localities, but there is a wide variation even locally in the number and thickness of the clay beds.

Origin of McMurray Formation. The large-scale cross-bedding present in some areas has been interpreted as the fore-set beds of a delta. The sand for the McMurray formation is considered to have originated from the east from the Precambrian Shield, and the McMurray formation is regarded as a deltaic or a shoreline deposit laid down on the edge of the Precambrian Shield. Most of the clay bands in the oil sands are considered to represent flood deposits of silt and clay originating from the same source as the sands and alternately deposited with them. This may account for the wide variations locally in the character of the oil sand deposit as well-washed sands may have been deposited in one place while silt and clay were being laid down in areas of more quiescence immediately adjoining. From the drilling done to date it appears that north of McMurray the McMurray formation thins out to the west rather rapidly, but the situation south of McMurray is still uncertain.

Origin of the Oil. There are two main schools of thought regarding the origin of the oil. Ball[1] and Hume,[9] among others, favor the "near source" hypothesis. They consider that the oil in the oil sands originated in or near its present location and was deposited contemporaneously with the McMurray formation, and that the oil is not a residual product left by evaporation and oxidation of lighter oil but is "a young oil that has never been geologically gently cracked or decomposed into lighter or heavier products." Sproule[14] and Link,[10] among others, favor a Devonian origin for the oil and consider that the oil escaped through fissures and fractures from the underlying coral-reef reservoirs of Upper Devonian age, and that this occurred primarily during—but also possibly subsequent to—the deposition of the Lower Cretaceous formations.

The Author

David S. Pasternack is senior research chemist with the Research Council of Alberta. He has a BSc degree from Queen's University, and an MSc and PhD from McGill. He first began work on the Alberta oil sands in 1929, and since that time has spent a total of 12 years on their study. He assisted in the operation of the two Government of Alberta pilot plants in the oil sand area — on the Clearwater River in 1930 and at Bitumount in 1949.

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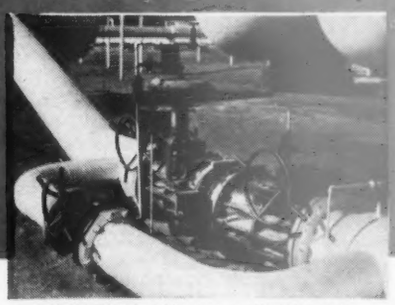

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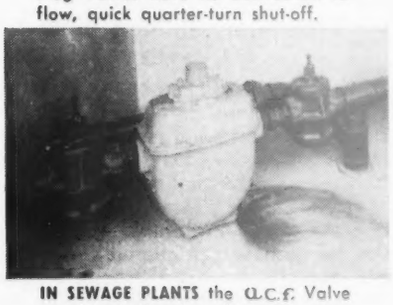

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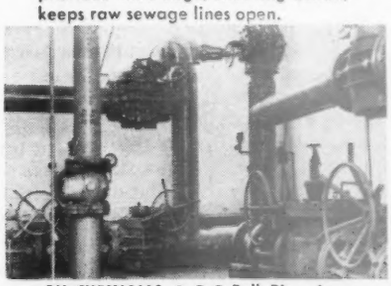

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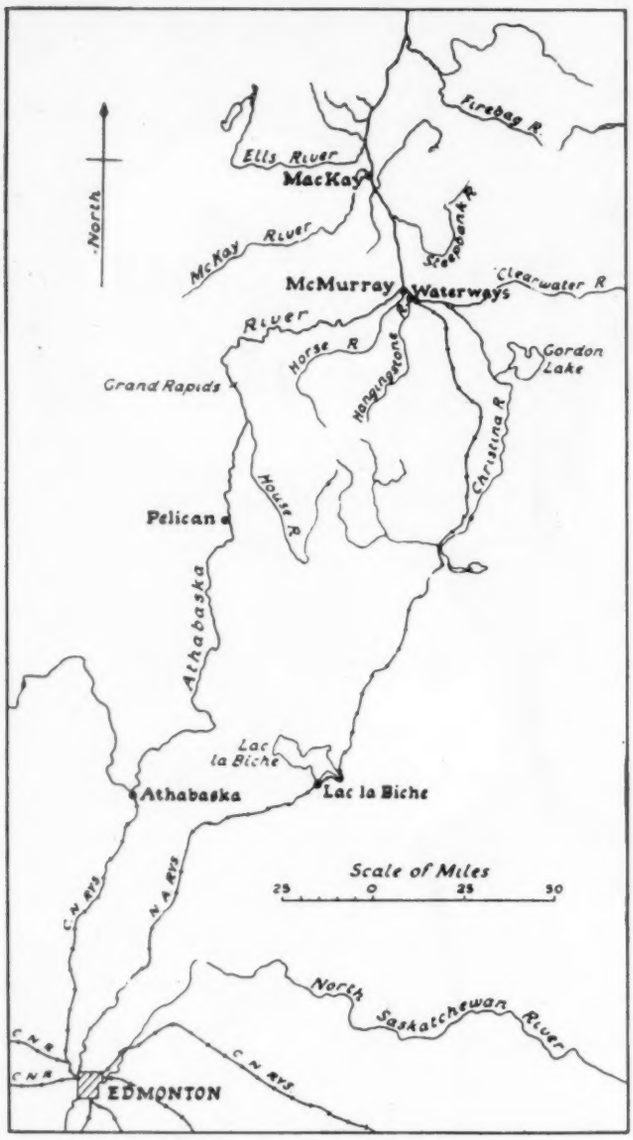

FIG. 3. Key map showing the location of the oil sand area in relation to Edmonton.

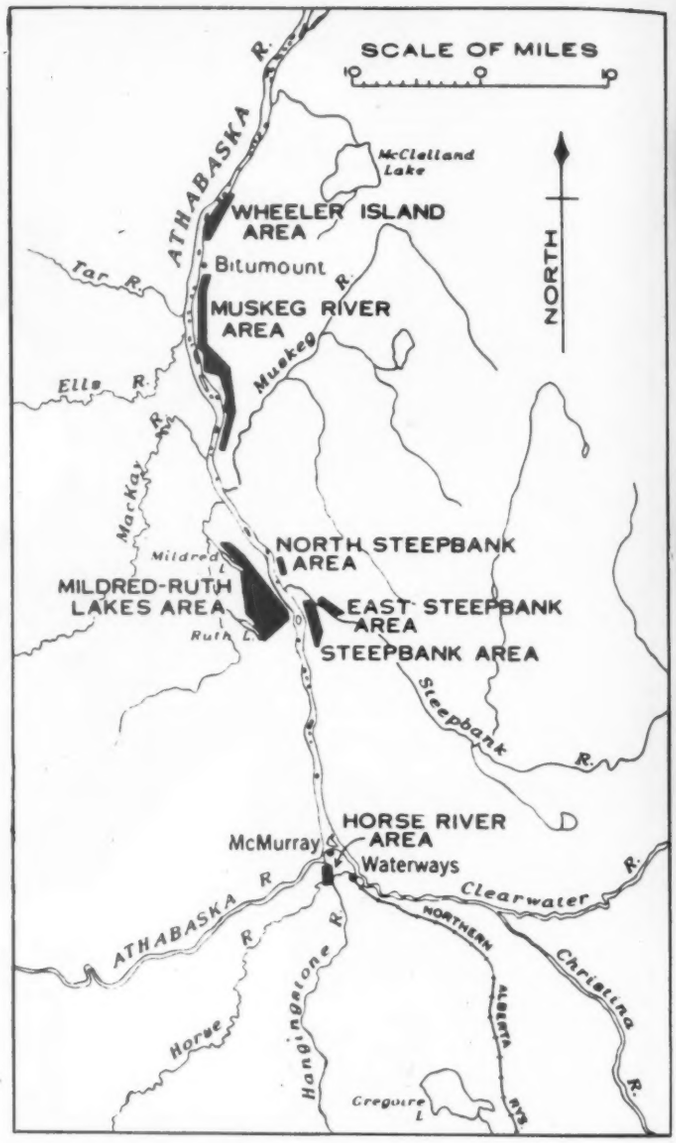

FIG. 4. Key map showing in black the areas explored by drilling during 1942-1947.

Exploratory Drilling in the Deposit

Prior to 1943 the amount of drilling, coring, and sampling that had been carried out in the oil sand area was very meagre and provided only "spot" information on the quality of the oil sands at a relatively few locations. There were indications of considerable variability in the oil sand formation, both vertically and laterally, as regards the oil content of the oil sand and its silt and clay content.[3]

From 1943 to 1947 Boyles Brothers Drilling Company of Vancouver, B. C., under contract to the Mines Branch of the Department of Mines and Resources, put down 291 holes for a total drilled footage of 53,918 ft in the areas shown in Fig. 4. (Fig. 3 shows the location of the oil sand area in relation to Edmonton.) Although the holes went to a maximum depth of over 300 ft, and averaged 185 ft, casing was unnecessary except through the overburden.[7] They found that the use of diamond or tungsten carbide coring bits together with a treated drilling fluid‡ facilitated good core recoveries. This drilling program further demonstrated the vertical and lateral variability of the oil sand deposit with respect to oil content, silt and clay content, depth of overburden, and the ratio of oil sand to overburden.

During the first six months of 1952 nine prospecting permits, each covering 50,000 acres, have been taken out by various oil companies for the purpose of carrying out an intensive program of core drilling and assaying. Seven of these reservations are on the west side of the Athabasca River and two on the east bank, each reservation having a river frontage of six miles where possible. During the next two or three years this drilling program—and probably others as well—will provide much more information than hitherto available regarding the richness of the deposit, variability in the oil content and in the mineral aggregate, and the relative amounts of overburden to oil sand. It should prove up other areas, which may be as satisfactory for large-scale strip mining operations as the Mildred-Ruth Lakes area. Fig. 5 shows oil sand in the Bitumount quarry being excavated by means of a power shovel.

Estimated Reserves. Estimates of the area overlain by the oil sands run as high as 10,000 to 30,000 sq miles and estimates of the amount of oil present as high as 100 to 250 billion barrels.[1] Recently, oil sand was cored from a well that was being drilled 75 miles south of McMurray, and oil similar to that in the oil sands showed up in a well over 100 miles west of McMurray. Naturally the question arises as to what portion of the entire area is of economic significance in the foreseeable future.

Where the amount of overburden is such that the oil sand can be removed from the formation by strip mining, the entire oil content is potentially recoverable. For example, in the Mildred-Ruth Lakes area, core drilling, and assaying indicated that 4½ square miles in this locality contained approximately 1,162,665,000 tons of oil sand averaging 13.6

‡"Aquagel" or "Altamud" treatment.

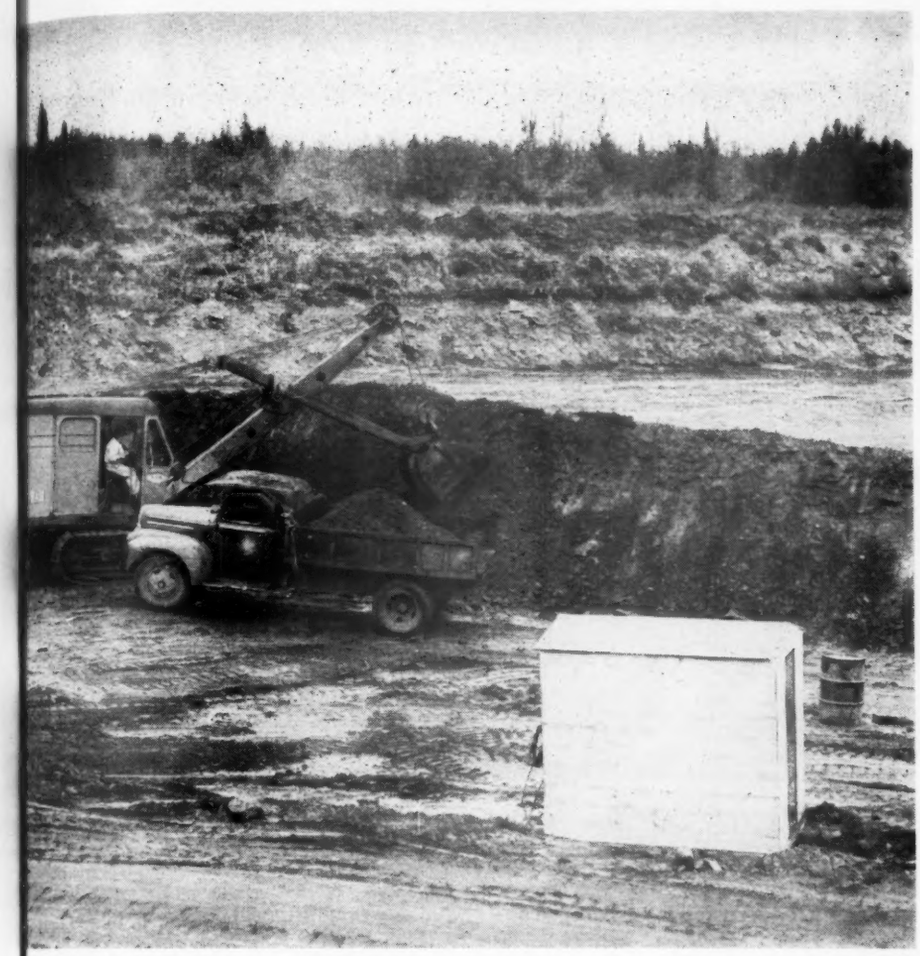

FIG. 5. Excavating oil sand in the Bitumount quarry. *(Alberta Government Photo)*

per cent oil, and the ratio of oil sand to overburden averaged 2.6:1. That quantity of oil sand contains approximately 900,000,000 bbl of oil, which would be sufficient, at 90 per cent recovery, to operate a 20,000-bbl per day plant for 100 years.[7] The maximum thickness of oil sand found in that area was 224 ft and the thickness of the overburden was generally about 30 to 60 ft.

Characteristics of the Oil Sand and the Oil. The oil sand is an aggregate of sand, clayey matter, oil, and water. The sand consists mainly of quartz particles of 50 to 200-mesh size and smaller, but minor amounts of other minerals such as mica, rutile, ilmenite, tourmaline, zircon, spinel, garnet, pyrite, and lignite also occur. Although silt and clay occur interbedded with the oil sand, they also represent a normal constituent of the oil said itself. Ironstone nodules of all sizes up to eight inches in diameter show up in the oil sand beds, especially in the southern part of the deposit.

Freshly mined oil sand has usually been found to contain about 2 to 5 per cent water and 10 to 17 per cent oil, the balance being mineral matter. The oil is viscous, naphthenic, contains about 5 per cent sulfur, and has a specific gravity of around 1.005 to 1.025, that is, about 6.5 to 9.5 deg API. The oil in the northern part of the deposit—containing about 15 to 20 per cent asphaltenes[11]—is less viscous than that in the southern part, which contains about 23 per cent asphaltenes, and hence there is a marked difference in the rigidity of the oil sand in the two areas. The formation temperature of the oil sand deposit is about 36 F.

A portion of the water in freshly mined oil sand appears to be present as films around the particles of mineral matter, thus separating the oil from direct contact with most of the mineral surfaces. It is this fact that facilitates the removal of the oil from the oil sand in the hot water separation process.

Methods of Oil Recovery

As mentioned above, only a very small proportion of the total acreage either known or assumed to contain oil sand deposits has been drilled, cored and assayed sufficiently to warrant large-scale development, but the amount of such exploratory drilling is increasing rapidly. Methods of "in situ" recovery—such as heating followed by water flooding, and electrovolatilization—have been suggested for areas where the depth of overburden is too great for economical strip mining to be carried on. Mining of the oil sand by underground block caving has also been suggested. Until such methods have been proved feasible, however, exploitation of the oil sands will, of necessity, have to be limited to those areas in which the oil sands can be obtained on an economical basis by strip mining and where adequate disposal areas for both the overburden and the tailings are available.

Four methods of oil recovery from the oil sands have been proposed:

1. Solvent extraction,
2. Hot water washing method,
3. Cold water washing method,
4. Retorting.

1. *Solvent Extraction.* Although solvent extraction would be effective, there is grave doubt that solvent losses could be held to a satisfactory minimum when handling huge quantities of solids.

2. *Hot Water Washing Method.* The hot water washing method is the method that has received the most intensive study to date as it appeared to be the one that held out the greatest hope for success. Stated briefly, this method as practiced by the Research Council of Alberta involves increasing the water content of the oil sand to about 12 per cent by means of hot water and/or steam while it is being heated to a temperature of about 175 F, during which time a certain amount of mixing or kneading of the oil sand takes place. A residence time of about 15 min in the conveyor and mixer is sufficient. The pulp is then dropped into a turbulent stream of circulating hot plant water. The circulating plant water washes the pulp into a comparatively large body of hot water in what is designated as the separation cell. In the separation cell the oil floats as a froth on the surface of the water and is skimmed off, while the bulk of the mineral matter sinks to the bottom and is removed and discarded. The plant water containing finely divided material in suspension is continuously withdrawn from the separation cell to a water settler, the overflow from the water settler being reheated to about 185 F before it is used for washing additional pulp into the separation cell. The process has considerable elasticity in many respects.[12] The oil froth usually contains about 30 per cent water and about 5 per cent mineral matter.

Although the pH of the plant water is of minor importance in the hot water washing process, the pH of the oil-sand pulp should be around 7 for the best separation results.[4] A pulp that is neutral or slightly alkaline is preferred. Freshly mined Alberta oil sand has a pH of about 7. At the pilot plant at Bitumount during 1949 about 15,000 tons of oil sand were made into pulp and the oil separated by means of the hot water process without any reagent being required by the pulp. An aerial view of the pilot plant is shown in Fig. 6.

The mineral aggregate of the oil sand contains silt and clay and the amount may vary up to about 15 per cent. A certain amount of silt and clay, say 3 to 5 per cent, is necessary for satisfactory separation to take place after a reasonable period of heating and kneading. The presence of too much silt and clay reduces the primary yield of oil.[5] The primary yield can be augmented by passing the underflow from the water settler through a conventional flotation cell.[12]

3. *Cold Water Washing Method.* The

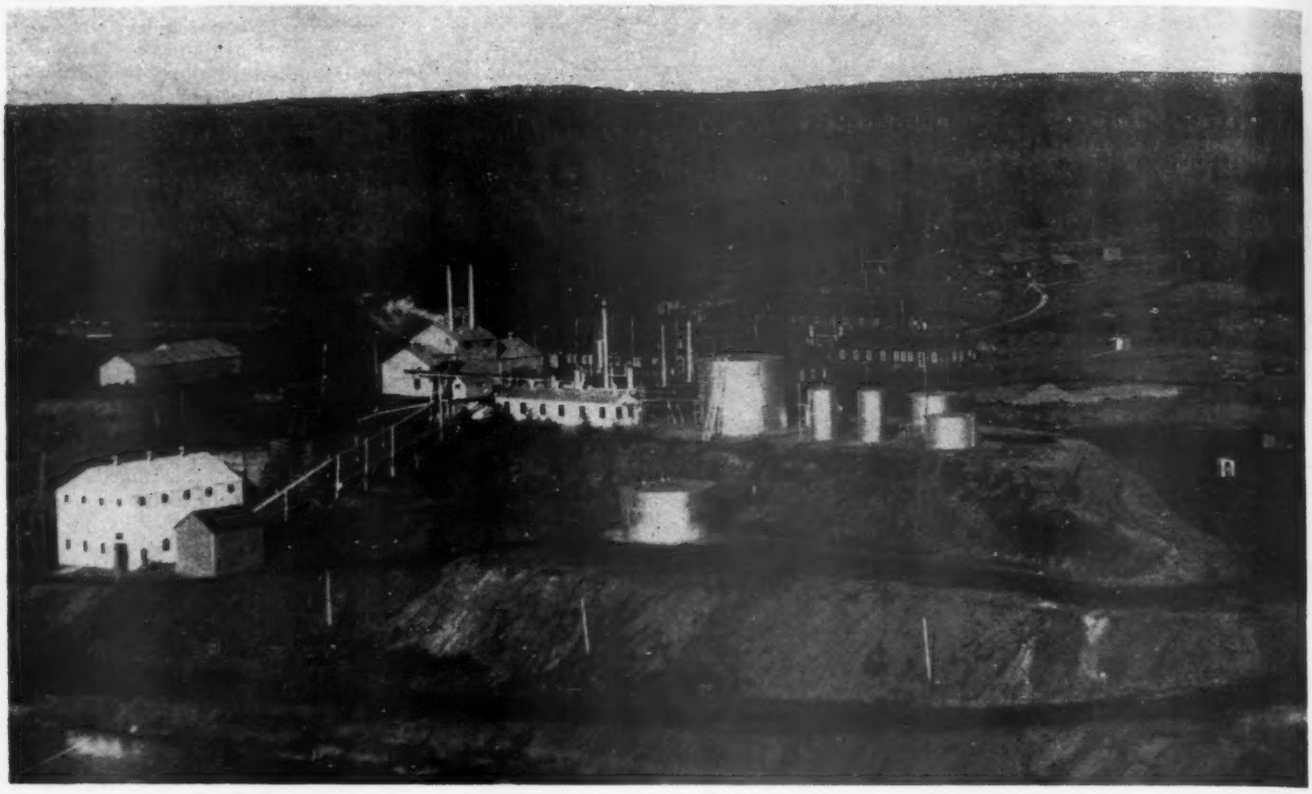

FIG. 6. The Government of Alberta pilot plant at Bitumount. *(Alberta Government Photo)*

cold water washing method as worked out by the Mines Branch, Ottawa, is operated at around 77 F. In this process an amount of diluent (having the approximate volatility of kerosine) equal in weight to the weight of oil in the oil sand, together with twice as much water as diluent, a monovalent alkali such as soda ash, and a wetting agent such as "Span 40" are all added to the oil sand in a pebble mill. After an appropriate residence time in the pebble mill the mixture goes to an agitator and then to a classifier from which the separated diluted oil overflows. After passing through a thickener[§] the overflow still contains about 25 per cent water and about 2.5 per cent mineral matter.[6] The cold water process appears to require much more careful control of the operating conditions than is necessary in the hot water process, as well as requiring the addition of diluent, monovalent alkali and wetting agent. To date the process has only been operated on a small pilot plant scale, the maximum throughput of oil sand being about 300 lb per hour.

4. *Retorting.* The development of the fluidized solids technique for catalytic cracking led to its application by the National Research Council, Ottawa, in the retorting of oil sand, the fluidized bed consisting of sand.[13] The product, without recycling, represented about 80 to 85 per cent by volume of a dry fluid oil having a gravity of about 16 API and containing about 4 per cent sulfur. During compilation of the Blair report[2], however, it appeared that the capital cost of equipment to retort huge volumes of oil sand in a fluidized bed would be too great, and this would be reflected in a higher cost per barrel for the product. In addition, the disposal of enormous volumes of hot sand tailings would be a problem. It seemed that a more feasible arrangement economically for the fluidized solids technique would be the "dehydration-coking" in one operation of the wet crude oil obtained as an oil froth in the hot water separation process. The yield of product and its gravity and sulfur content[13] appeared similar to what was obtained when the oil sand itself was retorted. In the pilot plant work to date the maximum throughput of oil sand has been about 100 lb per hour, and during the "dehydration-coking" the maximum throughput of wet crude oil was about 17 lb per hour.

It was indicated in the Blair report[2] that the sulfur content of the coker distillate produced by the fluidized retorting would have to be reduced considerably before it would be of acceptable quality for subsequent refining or marketing. Mild hydrogenation was considered as being the most economical means at present of accomplishing this reduction.

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Economical Aspects of Alberta Oil Sands

The Blair report[2] on the Alberta oil sands outlined a sequence of operations for possible commercial development of the oil sands. It was estimated that the cost of the desulfurized oil product, containing 0.26 per cent sulfur, laid down at Superior, Wisconsin, would be $3.10 per barrel, the break down of the cost being as follows:

Production item		Cost per barrel
Strip mining, including overburden removal....		$0.55
Hot-water separation of the oil from the oil sand, plus fluidised coking of the wet crude oil....		0.72
Desulfurization of the fluidized coker distillate by mild hydrogenation.....		0.81
Pipeline transportation charges:		
(a) From oil sand area to Edmonton	$0.28	
(b) From Edmonton to Superior....	0.55	
(c) Storage and all other transportation expenses additional to the direct line costs.....	0.19	
	$1.02	$1.02
Total production cost at Superior.....		$3.10*

*The pipe line transportation charges of $1.02 is on a basis that provides a satisfactory profit directly on the capital involved. No specific allowance, however, was included in the mining and processing costs totalling $2.08 for interest or profit on the capital.

The desulfurized oil product containing 0.26 per cent sulfur had a gravity of 26 API, showed a Conradson carbon residue of 1.22 per cent, and consisted of about 88 per cent gas oil and 12 per cent gasoline. Based on a value of $3 per barrel at Superior for Redwater crude of 30 API gravity, it was assumed in the Blair report that the desulfurized oil product from the oil sands would have a value at Superior of at least $3.50 per barrel after making allowance for expenses that would be incurred in adjusting the quality.

The net result of the above estimates —$3.10 per barrel for total production cost and $3.50 per barrel as the value of the product—is to show a possible realization of $0.40 per barrel. Based on a total capital expenditure for mining and processing of $43,600,000 on which interest and profit is required, and with an annual production of 6,000,000 bbl (20,000 bbl per day for 300 days), the profit of $0.40 per barrel would yield 5.5 per cent on the investment.

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Leasing Regulations and Royalties

The policy of the Government of Alberta with respect to oil sands' development was outlined by the Hon. N. E. Tanner[15], Minister of Mines and Minerals, at a conference dinner tendered the delegates to the Oil Sands Conference at Edmonton in September, 1951. Stated very briefly, the policy is as follows: Maximum area to be included in a prospecting permit is not to exceed 50,000 acres, the fee for the permit is to be $250, and the rental payable would be five cents an acre for the first year, 10 cents per acre the second year, and 25 cents per acre the third year, a deposit of $50,000 being required from the applicant to guarantee that a satisfactory exploration program would be diligently conducted. The nature of the deposit as determined by the exploration program and the proposed capacity of the plant to be erected would be the main factors in determining the acreage that may then be applied for under lease. The annual rental for a lease would be $1 an acre payable yearly in advance and the royalty to be collected during the first 21-year term of the lease would not exceed 10 per cent of the raw products extracted from the oil sands. The lease would require that construction of a plant of the agreed capacity must be commenced within two years of the granting of the lease and be completed and in operation within five years of the granting of the lease.

Future Development

There is sufficient readily-accessible oil sand proved up in the Mildred-Ruth Lakes area alone to support a substantial oil-sand development for many years. The Steepbank River area directly across the Athabasca River also contains substantial proved reserves. The intensive exploratory drilling program that is currently in progress along both banks of the Athabasca River should prove up additional large reserves that could be readily exploited by strip mining operations.

It is generally agreed that it is easier and more economical to extract the oil from the oil sands than it is to produce oil from either oil shale or coal. Furthermore, the response of the components of the desulfurized oil product from the oil sands to further refining is quite similar to the response of the components of normal crude oils. Consequently, when the oil industry turns to synthetic fuels to augment the supply of oil from crude oil wells for our ever-expanding economy, the Alberta oil sands will probably receive first consideration. The active interest now being taken in the oil sands would lead one to believe that commercial development is not too far distant.

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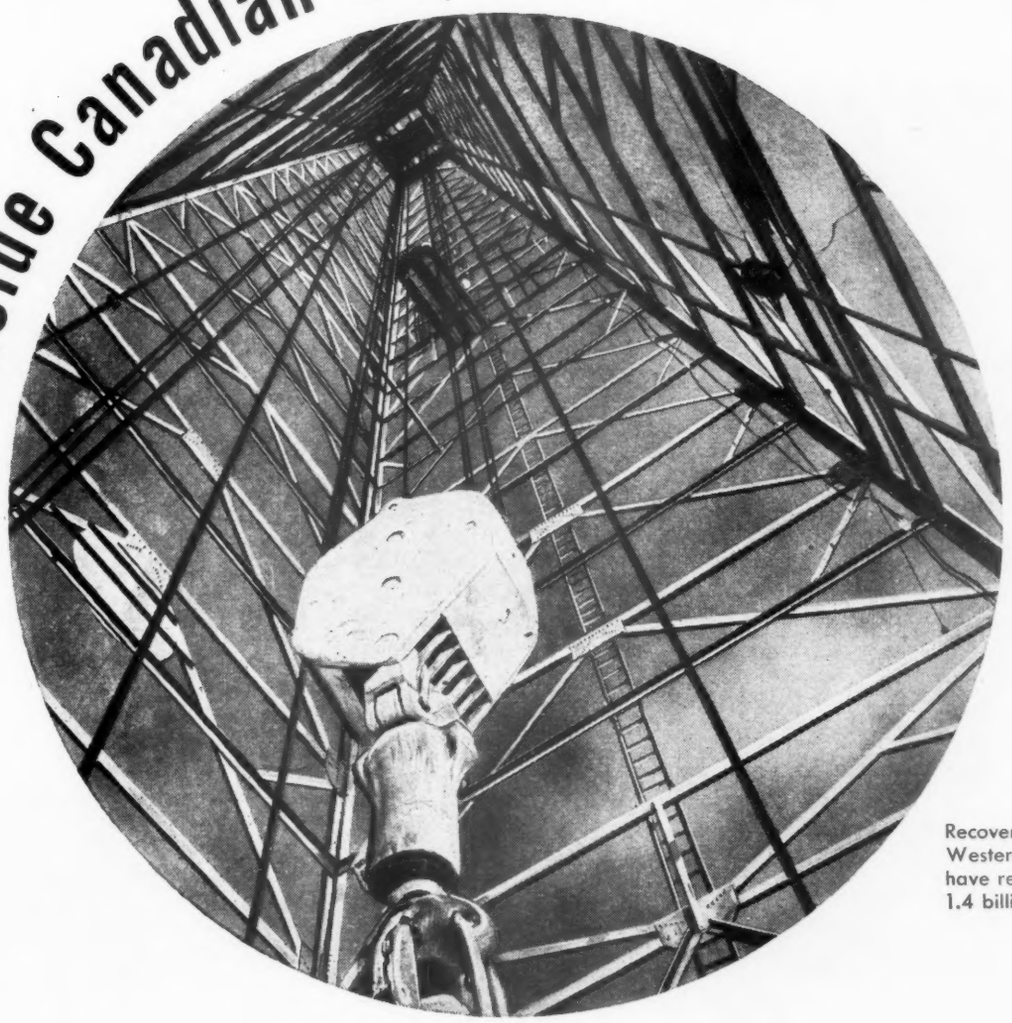
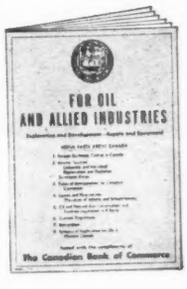


Recoverable crude reserves in Western Canada's oil fields have reached an estimated 1.4 billion barrels . . .

The Canadian Bank of Commerce—and its "banker-geologist" team—are equipped to give *efficient* assistance, based on *practical* experience, in problems concerned with Canadian oil financing. Our services have proved of value to many successful oil men. They can be of value to *you.*

Our brochure "For Oil and Allied Industries" contains information on leases and reservations, conservation, taxation, customs and immigration regulations, field data and other matters of importance to any operator interested in the Canadian oil and gas producing picture. Write for your copy to



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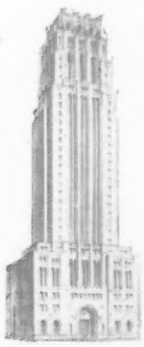

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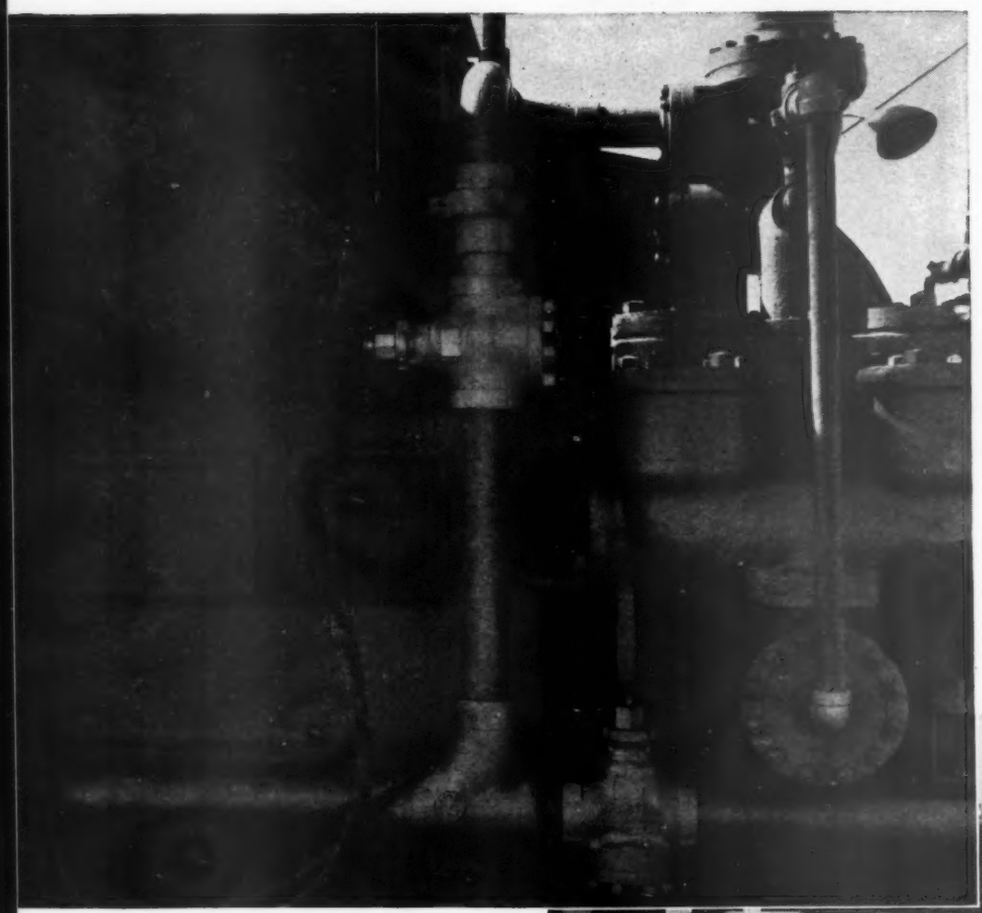
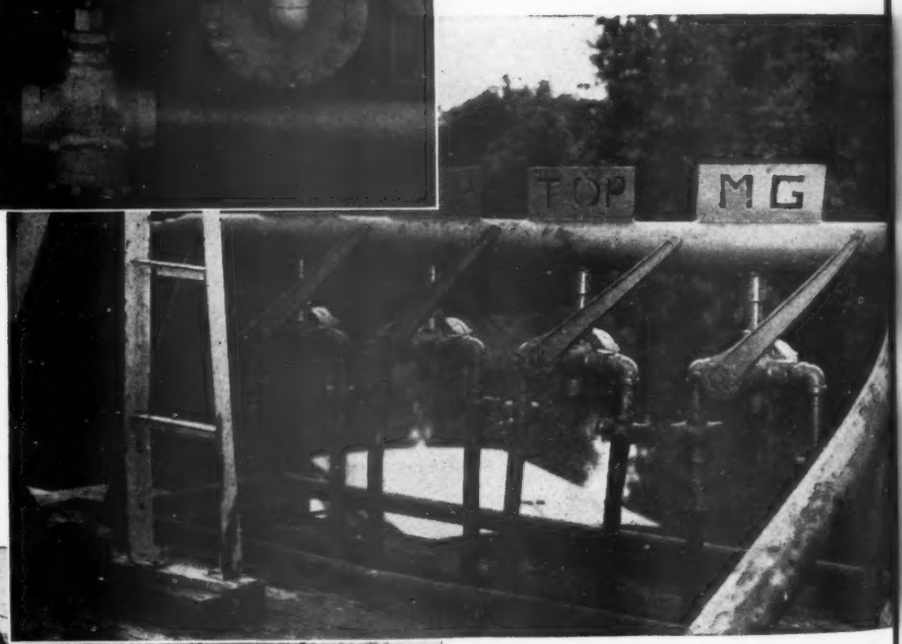


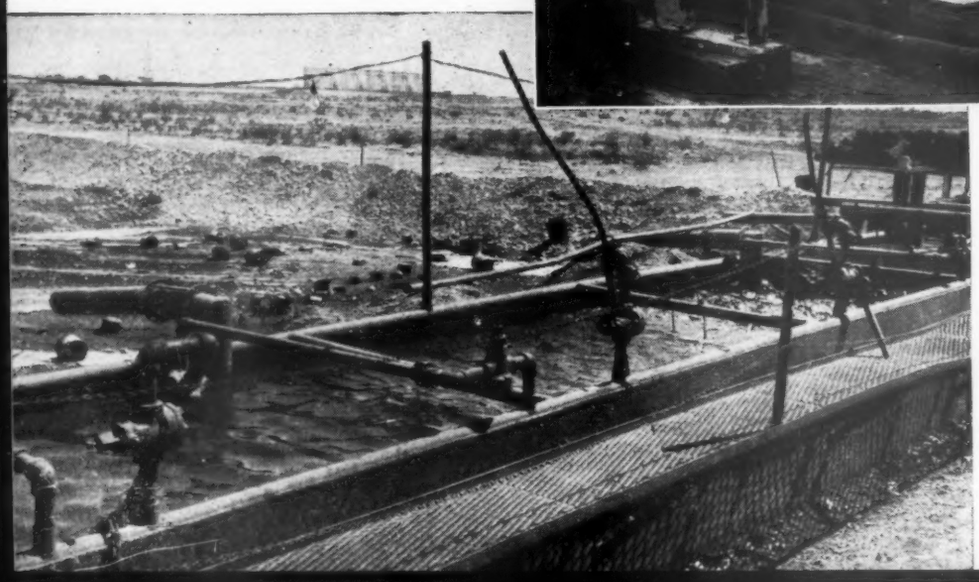
ARMOR-PLATED AGAINST MUD

Erosive drilling mud cannot eat away vital seating areas of Nordstrom Merchrome coated Hypreseal mudline valves like these installed on mud pump lines.

QUICK EMERGENCY OPERATION

It takes only a quarter turn to operate these Nordstrom three-way Hypreseal valves on blow-out preventer manifold. And Nordstrom lubricant keeps the valves ready to turn. Nordstrom valves on this service are a real safety factor





NO PLACE FOR SEDIMENT

With Nordstrom valves there are no cavities, pockets or bonnet chambers to catch line sediment and build up a dangerous dam in the line. Nordstrom's straight-through flow plus unexposed seating surfaces are a natural for mudlines.

Nordstrom Lubricated

VALVES ARE BEST FOR MUD LINES

Nordstrom Hypreseal Mudline valves are built specifically for use with all types of drilling mud. Their design eliminates the causes for valve deterioration in this difficult drilling service.

Here are three of the reasons Nordstrom valves last up to 10 times as long—by actual field test as ordinary valves in drilling mud service . . .

1. Armor-plated with Merchrome

Nordstrom Hypreseal valves can be had with body and plug seating surfaces coated with an integral layer of Merchrome—an extremely hard non-galling corrosion and erosion resistant special alloy. This means that even the cutting action of abrasive drilling mud has a hard time making a dent in Nordstrom Merchrome valves.

2. Open or Closed in a Split Second

It takes only a quarter turn of the Nordstrom plug to open or close the valve—seconds instead of minutes, and how important that may be in an emergency! The hydraulic jacking action of the lubricant keeps the plug ready to turn.

3. No Sediment-Catching Pockets

Straight through flow with no body or bonnet chambers in which clogging deposits can build up. And, since the seating areas are out of the line of flow, wear is spared on vital parts.

Of course there are other advantages—the sealing film of lubricant around the ports for double tightness, the availability of special Nordstrom lubricants for drilling mud service, the simple, compact, space- and weight-saving design.

Sum it all up this way . . . for drilling service there are no valves like Nordstroms. The best way to convince yourself is to give them a try. Your Nordstrom sales engineer will help you choose the right types for your service. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Merchrome hard-faced Nordstrom Hypreseal Mudline valve

Wherever you are in the oil fields, there's a supply store with Nordstrom valves and Nordstrom service nearby.

ROCKWELL Built Nordstrom Valves

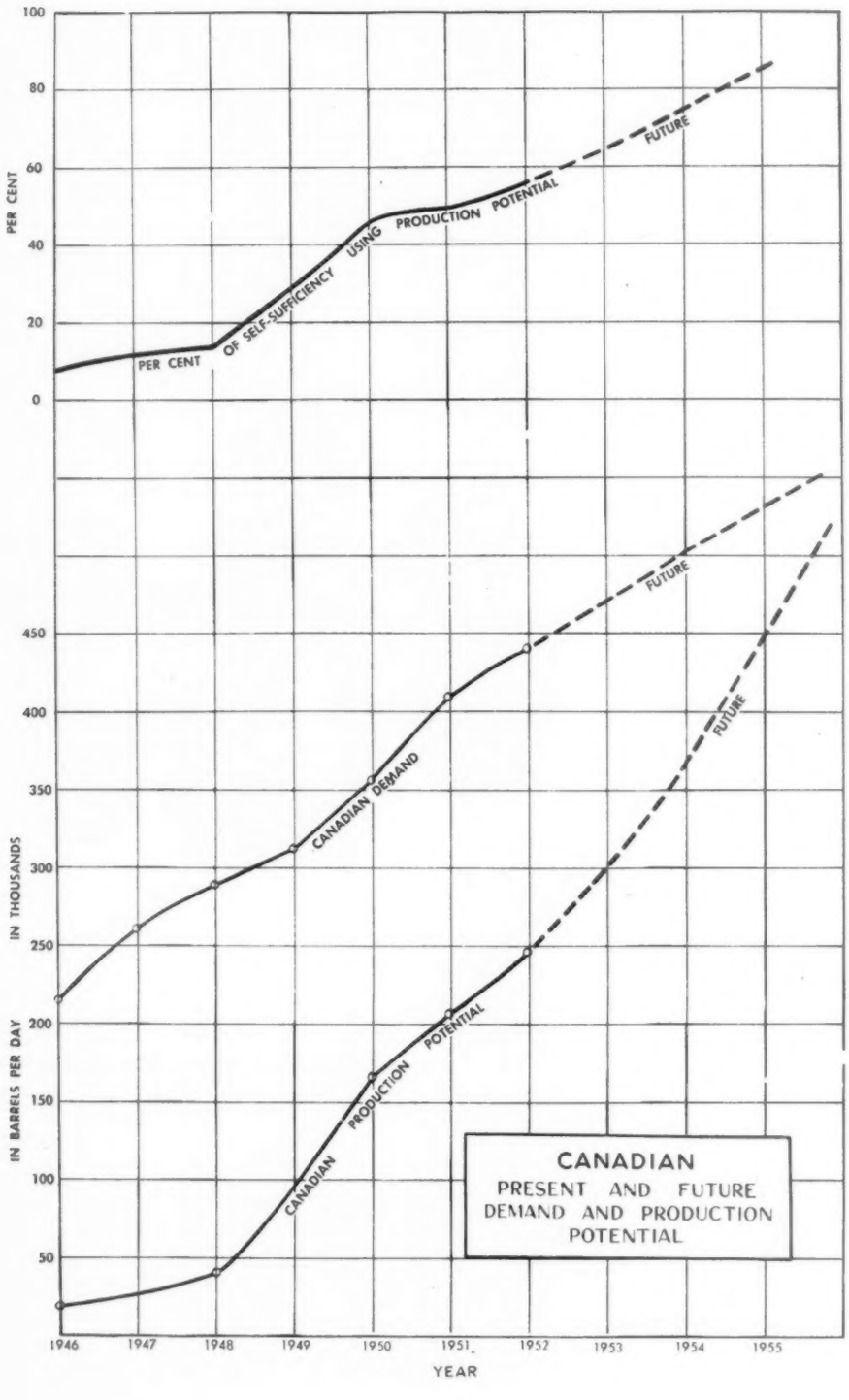
Lubricant-Sealed for Positive Shut-Off

Another ROCKWELL Product

Canadian Oil Industry Continues to Expand

In 1953 Prairie market will average 115,000 bbl daily and storage at Superior is being raised from 1,800,000 to 5,000,000 bbl

ERNEST C. MANNING*



THE provision of additional outlets for crude oil has been the principal problem confronting the Alberta oil industry and the one which best characterizes the development that has taken place in the province since the Leduc discovery of 1947.

The Hon. E. C. Manning

In 1946, Alberta was scarcely producing sufficient oil to supply her own needs and the oil industry was seeking sufficient reserves of natural gas for the production of synthetic gasoline. Refineries were faced with the prospect of importing crude to supplement the dwindling production of Turner Valley, the only significant light crude field. Saskatchewan was principally an importer of crude oil for refinery stock, while Manitoba was dependent on Ontario supplies of refined products made from imported crude. British Columbia was using water-borne supplies of crude oil and refined products from California and crude from Venezuela.

The significance of the Leduc discovery soon became apparent to Canadians generally and residents of Western Canada in particular. By the middle of 1949, the entire prairie demand for crude oil had been met as a result of the unprecedented exploration and development program that followed.

The principal sources of the increased production were the Leduc and Redwater fields. These and other discoveries brought Alberta's oil production potential from 20,000 bbl per day in 1946 to 100,000 bbl per day in 1949. Prairie refinery capacity, although greatly expanded following the Leduc discovery, was only capable of handling 55,000 bbl per day. The industry had to look afield for new markets.

The Alberta discoveries were not adjacent to any major oil market. Pipe line construction was essential to overcome high frieght rates. Several terminals for the proposed pipe line were considered. Across the mountains was the British Columbia and Pacific Northwest market area. The small refinery capacity of this region totaling less than 25,000 bbl per day made the Rocky Mountains too formidable a construction barrier for the market to warrant. No concentrated market existed across the United States border to the south. Hence the decision was made to construct a 1129-mile line from Edmonton to the head of the lakes at Superior, Wisconsin. This provided an easy prairie route for the line and cheap lake transport for the remainder of the way to a southern Ontario market. The growing prairie demand could be served en route.

Construction was begun early in 1950 and completed in 150 days. By the time lake navigation was opened in 1951, it was realized that what had appeared to

*Minister of Mines and Minerals in the Alberta Government.

EXCLUSIVE

be an optimistically oversized line in 1950 was actually not equal to the task of keeping ahead of Alberta's production potential. The capacity out of Edmonton was 95,000 bbl per day and maximum lakehead delivery capacity was 70,000 bbl per day. The seasonal nature of lake navigation was a major bottleneck. This situation was aggravated by similar seasonal fluctuations in the growing prairie demand. Production in 1951 averaged 132,000 bbl per day, compared with a production potential of over 200,000 bbl per day.

There were two possible ways of meeting the problem. One was to increase the capacity of the existing pipe line. The other was to construct a line to other markets. It was decided to loop sections of the Superior line and to build additional pumping stations. This raises the flow out of Edmonton to 140,000 bbl per day and the Superior terminal capacity to 95,000 bbl per day. Storage facilities at Superior are being raised from 1,800,000 bbl to 5,000,000 bbl to accommodate production during the winter months. The principal market for oil arriving at Superior is the refineries of southern Ontario, but in the fall of 1951 a refinery in the vicinity of the terminal became the first United States refinery to operate on Canadian crude. The newly constructed unit took approximately 4000 bbl a day. Another refinery being completed in the area will have a 12,000-bbl per day capacity. This makes the first substantial export of Canadian oil and is another step toward the day when this nation, on balance, is producing a quantity of crude equivalent to our own requirements.

Even with the increased capacity of the pipe line to the east, it appeared that there would be a considerable excess of potential production over the demands of the available market. In addition to mounting reserves in Alberta, there was increasing evidence that each of the other three western provinces might be developing light and medium gravity crude reserves of their own. An indication of the faith that the industry has in development of the western Canadian sedimentary basin was the decision to undertake construction of a pipe line across the mountains to the west coast market area. Construction of the 711-mile, 24-in. line was started in 1952. Completion is expected in August of this year. Initial capacity of the line will be 120,000 bbl per day. By adding more pumping stations this may be raised to 200,000 bbl per day. Vancouver's refinery capacity is being increased to 45,000 bbl. A refinery is being constructed in the vicinity of Bellingham, Washington, to process 35,000 bbl per day. As a result of the reduction in the United States tariff on crude oil from 21 cents per barrel to 10½ cents, Alberta oil will be able to compete more equitably with California and other crudes for offshore markets. An initial market of 75,000 bbl per day is anticipated. Completion of the Bellingham refinery will raise this throughput to near the line's initial capacity some time in 1954. With California forced to import over 75,000 bbl of crude per day to keep present commitments there will be an opportunity that in the next two or three years the Trans Mountain pipe line will have a market for its full capacity of 200,000 bbl per day.

In the meantime, plans are being made to connect the Superior terminal of the eastern line with Sarnia by 625 miles of 30-in. pipe with an ultimate capacity of 300,000 bbl per day. Present plans anticipate a flow out of Superior to Sarnia of 84,000 bbl per day which, with the market at Superior, will dispose of 100,000 bbl of oil daily.

Meanwhile the prairies are providing the fast-growing market in Canada. Refinery capacity in the three provinces has increased from 40,000 bbl per day at the time of the Leduc discovery to 125,000 bbl per day in 1952. In 1953 the prairie market is expected to use an average of approximately 115,000 bbl per day.

The anticipated 1954 market for western oil may be summarized as follows:

Prairie Provinces . . .	115,000
Pacific Coast	120,000
Eastern market	100,000
* * *	335,000

The Canadian Picture — Operatingwise

On natural gas the royalty is 5 per cent of the value but not less than one-half of 1 cent per thousand cubic feet. On all other products the royalty is in accordance with the following schedule:

Total monthly production	Percentage
900 bbl or less	5%
over 900 but not over 1200 bbl	6%
over 1200 but not over 1500 bbl	7%
over 1500 but not over 2100 bbl	8%
over 2100 but not over 2700 bbl	9%
over 2700 but not over 3300 bbl	10%
over 3300 but not over 3900 bbl	11%
over 3900 but not over 4500 bbl	12%
over 4500 but not over 5100 bbl	13%
over 5100 but not over 6000 bbl	14%
over 6000 bbl	15%

License

No one shall commence any drilling operation without a Government license. This applies both to Government and freehold lands. The application for a license must give all particulars required by the regulations and be accompanied by a fee of $10 and a deposit not exceeding $5000 to insure that operations will be conducted in accordance with the regulations. If the applicant intends to carry out operations in respect of two or more wells he may make a deposit of not more than $25,000 as security that his operations in respect of all wells will be conducted in accordance with the regulations. In the event of default not more than $5000 shall be forfeited in respect of any one well.

*Data courtesy The Canadian Bank of Commerce, Calgary, Alberta.

A license may be granted for drilling only or operating a well only or for both. In any case where operations have not been carried on for ninety days the license may be cancelled but may be reinstated if the Government is satisfied that failure to carry on operations was owing to conditions beyond the control of the licensee.

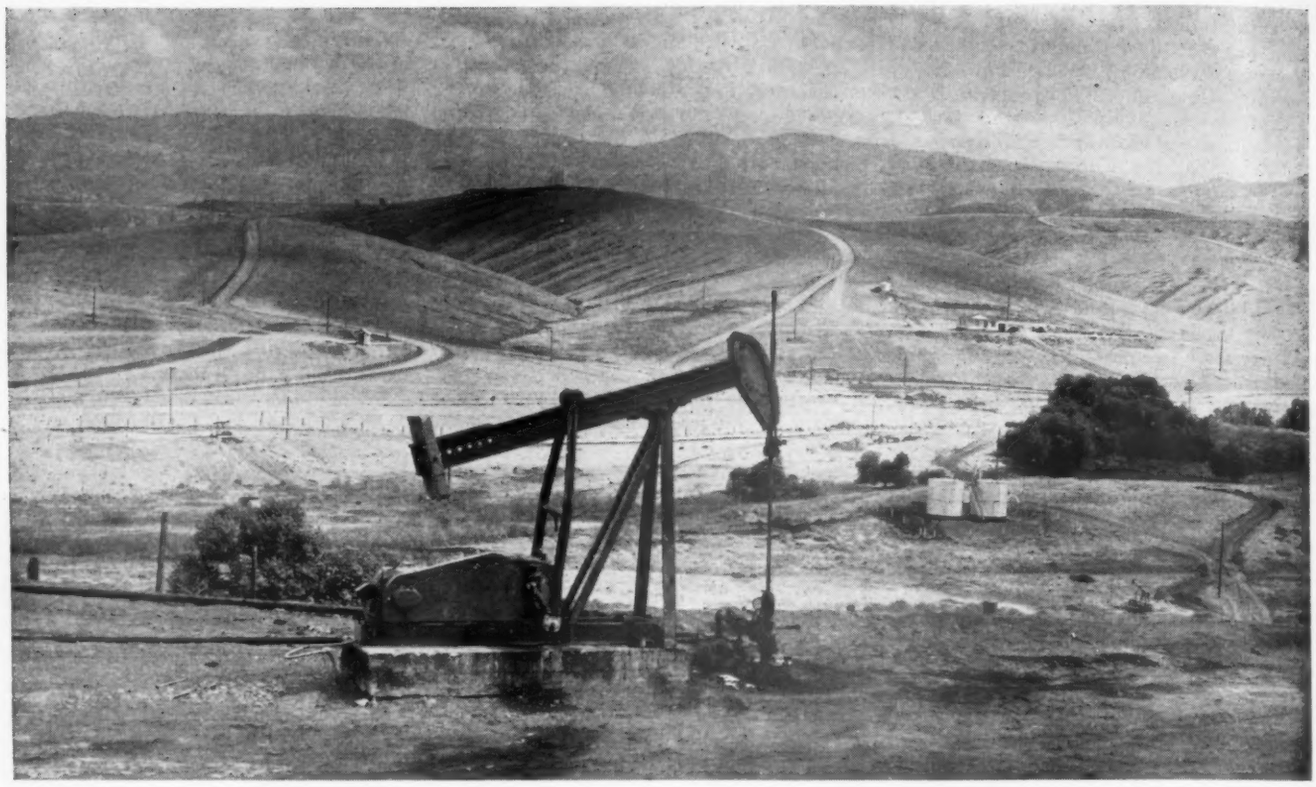
Drilling

No well may be drilled within 200 ft of any roadway, railway, dwelling, school, church or boundaries of the area controlled by the operator. No water flushed drill shall be used without the approval of the Government. Daily reports of operation must be prepared, one copy whereof must be retained at the well and one copy sent weekly to the Government. The Government must be notified immediately of any oil, gas or water encountered in a well and when oil or gas is discovered in sufficient quantity a sample shall be preserved and sent to the Department for analysis. Samples of formations must be taken at depths of not more than ten feet apart and sent to the Department when required. When water is encountered the operator must immediately close the well to prevent the water from gaining access to the oil and gas bearing formation. There are other regulations which are, in the main, in accordance with generally accepted practices.

Inspections

Any person authorized by the Department may at any time inspect any well, equipment and records and may take samples. Information so obtained shall be kept confidential. * * *

The Alberta Foothills. Rocky Mountains divide British Columbia and Alberta. East of the Range the hydrocarbon accumulations of Western Canada have been found to date.



Quake casualty is Steele Petroleum Company's Roco No. 46. It was completed 4 days before the earthquake for 54 bbl a day of clean 30-gravity oil from 617 ft. Quake damage has cut production to less than 6 bbl a day. Operators are unable to get back in the hole and, when the well sands up, it will be abandoned. Well is pumping less than 6 bbl of fluid a day at the present time.

Earthquake Damage in Kern County

Odd things happen when the earth trembles but oil and gas properties got off better than expected

WILLIAM T. RINTOUL

AN immediate concern in California's recent earthquakes, Kern County's rich oil industry, apparently has escaped major sub-surface damage at the hands of the two "killer" quakes and hundreds of tremors that since July 21 have taken 13 lives and caused more than $50,000,000 property damage in Bakersfield, the county seat, and neighboring communities.

Due to the difficulty of immediately assessing what damage, if any, had been inflicted deep below the earth's surface, oil operators only recently completed damage surveys on their leases.

Findings not only indicate that the oil industry came away with relatively light losses but also provide an interesting, if not completely understood, picture of what happens to oil wells and oil fields when the earth is shaken with mighty tremors.

Following the initial quake on July 21, the strongest registered in California since the disastrous San Francisco earthquake in 1906, it was feared that many wells might have sustained serious underground pipe damage. More than 13,000 active producing wells, which last year produced $201,335,000 worth of crude oil, were shaken up by the abrupt displacement along the White Wolf fault, which runs approximately northeast from Wheeler Ridge to Caliente in Kern County.

Careful surveys completed in the shaken fields, however, have disclosed only a limited number of cases of subsurface damage to oil wells.

A small lease owned by Steele Petroleum Company in the Tejon Hills field, within a stone's throw of the White Wolf fault, seemed to catch the full force of the earth's movement.

EXCLUSIVE

Four producing wells, one of them completed only four days before the earthquake, were ruined. A 1500-bbl storage tank was flattened, spilling 800 bbl of 30-gravity oil. Smaller tanks, pump units, and other installations were damaged.

Movement of the earth twisted and crushed pipe in the ruined wells, seeming to hit hardest at about 485-500 ft, as far as it is possible to tell from the bent pipe that has been recovered from certain wells. Damage to the casing makes it impossible to get into certain wells.

One of the hardest hit wells was Steele Petroleum Company's Roco No. 46, a 617-ft well that was completed four days before the first earthquake. Production was stabilizing at 54 bbl a day of clean 30-gravity oil when the quake struck. Today the well is pumping less than 6 bbl of fluid a day.

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More than twenty Airco Hardfacing rods are ready to help you beat today's replacement delay. Full equipment protection with Airco Hardfacing Alloys . . . for new parts and old . . . keeps you free of cut-backs, or loss of day-to-day production.

Parts and tools – fishtail bits . . . roller bits . . . core heads . . . wall scraper blades . . . drag type bits – stay on the job longer, even at peak production, their life extended many times with *Airco Hardfacing Alloys.*

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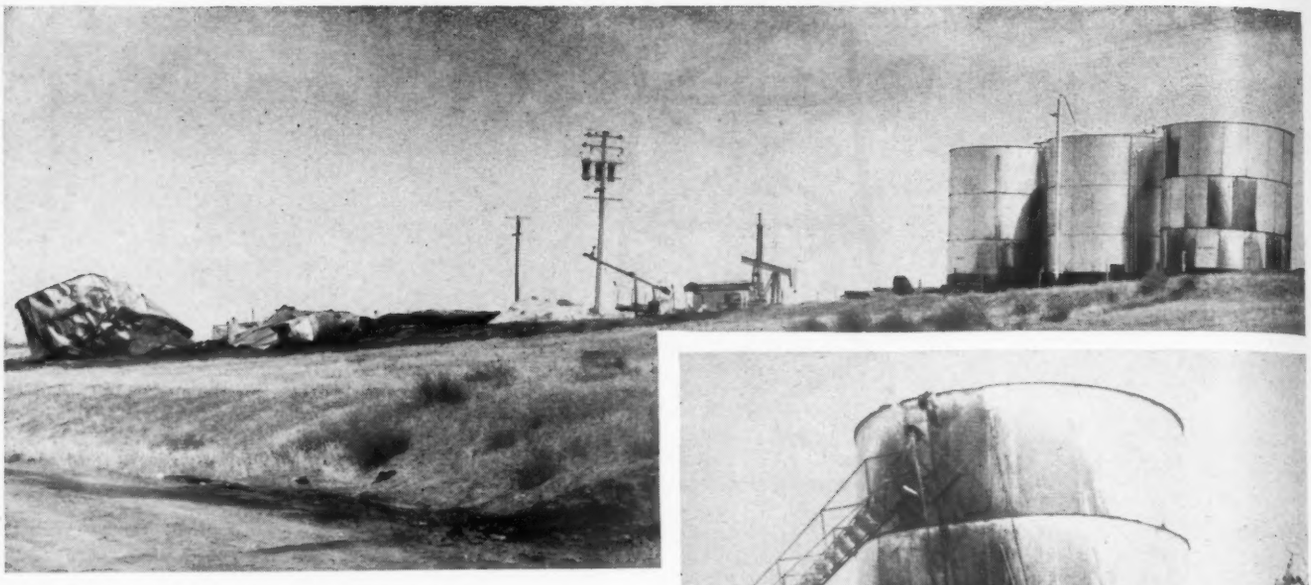
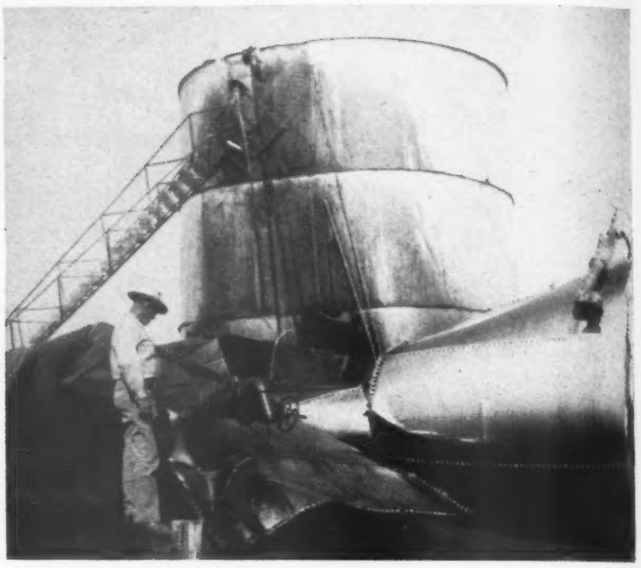


Crumpled tank at left in photo above was the center tank in the setting on the hill when the first major earthquake struck Steele Petroleum Company's Roco lease at Tejon Hills. The since-replaced tank was hurled down the hill, while its two mates were not seriously damaged.



Force of the earthquake crumpled a 1500-bbl storage tank (right), spilling 800 bbl of 30 deg gravity oil on Steele Petroleum Roco lease at Tejon Hills, Kern County, California.

Production from the lease's 34 shallow wells averaged 1100 bbl a day before the earthquake. Following the quake, with the loss of at least four wells and possible loss of two others which were badly damaged, production dropped about 200 bbl a day.

Within six weeks of the quake, most of the damage to installations had been repaired. A new tank was put up to replace the 1500-bbl storage tank which crumpled, and other tanks were righted.

Steele Petroleum Company will replace the ruined wells with new wells as soon as a drilling rig is available to move in to do the job.

In the 24-year-old Fruitvale field, about 20 miles northwest of the quake's epicenter, gas pressures increased almost immediately at many old wells and fluid output dropped. Within a few days, pressures began to decline and fluid output returned to normal.

Petroleum engineers are still attempting to find a logical explanation for such behavior, which was noted to a lesser degree in other older fields.

One engineer explained it this way: If you take a bottle of Coca-Cola, shake it up, and then try to pour some out, you get mostly fizz in your glass. But, after you let the bottle sit for awhile, you find you can pour the coke without any trouble—just like you always did before.

Drilling rigs were shaken up by the first major quake, and many of the tremors, but none reported stuck pipe or trouble with the hole as a result of the disturbances. One rig in the Fruitvale field had more than 4000 ft of drill pipe out of the hole when the first quake struck. Pipe was scattered to some extent, but no real damage resulted.

Of course, many of the first reports on the quakes concerned the actions of the men who happened to be working when the tremors began. One wildcat at Wheeler Ridge reported the only casualty was a rotary helper who inadvertently plunged into the mud pit in a frantic flight for safety.

Tubing was being run at another well in the Fruitvale field when the first major shock occurred. According to eyewitnesses, the derrickman gave one of the best high wire performances ever seen, even if it was somewhat of an unwilling act.

Deepest test active in Kern County when the first, and biggest, earthquake struck was The Ohio Oil Company's KCL-A No. 72-4 in the Paloma field, roughly 20 miles west of the White Wolf fault.

Ohio's deep test was coring at 14,310 ft and, even with more than 20 tons of drill pipe in the hole to serve as an anchor, the rig reportedly swayed precariously. Ohio's crew pulled the pipe off the bottom of the hole and circulated for most of the remainder of the day.

One groundless fear was that the quakes, by shaking up the producing oil sands, might ruin production. August Prunotto, owner of a 20-acre farm in the Rosedale district immediately west of Fruitvale, was typical of those who thought their wells might dry up.

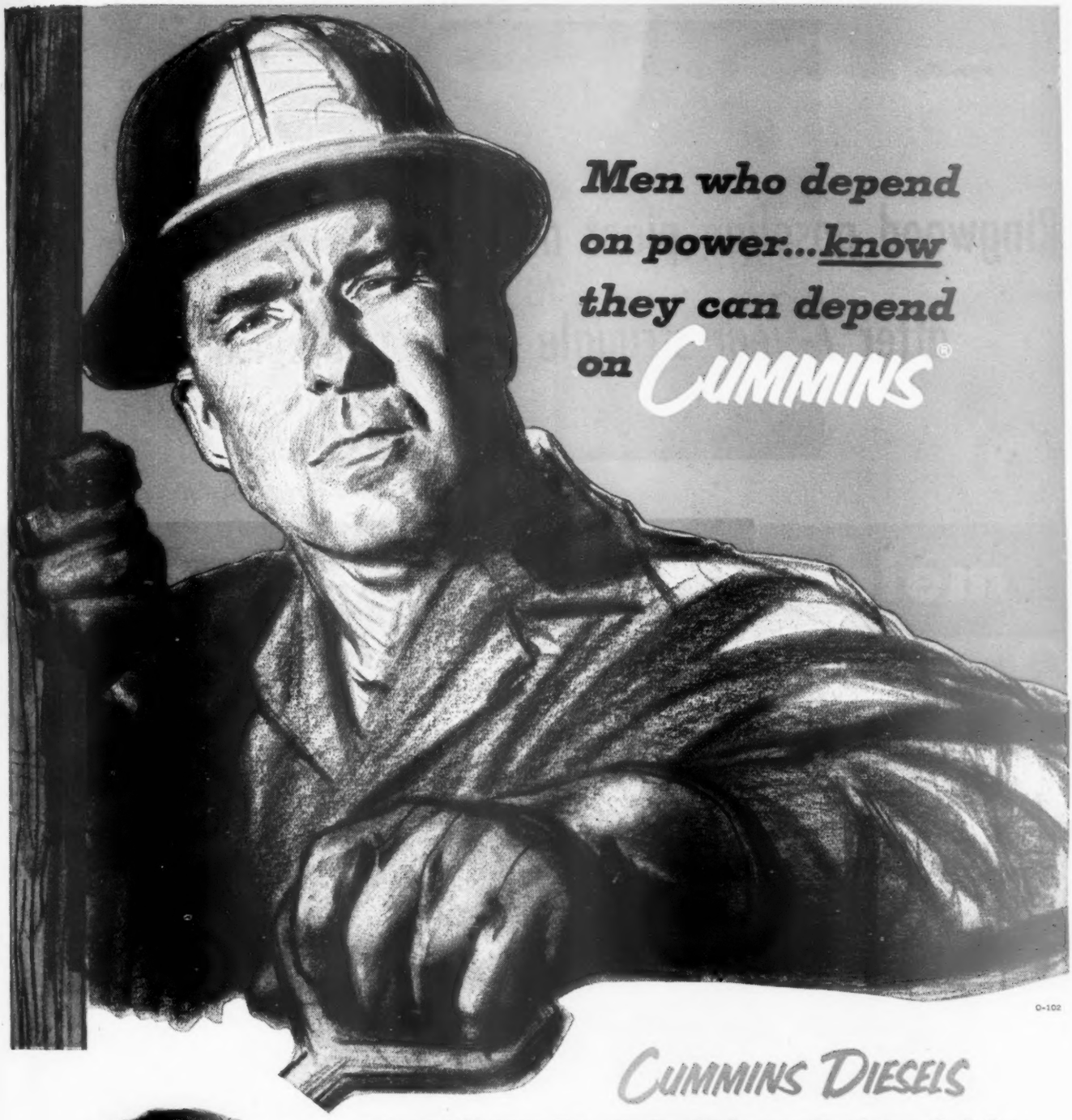
When the first early morning quake struck, Prunotto jumped out of bed and, unmindful of the condition of his shaking house, rushed out to the well which Humble Oil and Refining Company had drilled in his backyard He apprehensively opened the valve which tapped the well's flow line and did not breathe easy until he saw a brown, reassuring stream of oil flow out of the line.

In the 52-year-old Kern River field immediately north of Bakersfield, most wells went through the first quakes without damage only to sand-up on the last big quake on August 22. About 75 of the more than 2700 shallow wells in the field sanded up, necessitating overtime work by busy well-pulling crews for more than a month before all the wells could be returned to production.

Power failures, ruptured production lines, and the necessity of shutting in wells in the Paloma field, where the quake touched off a $1,500,000 fire in the cycling plant, resulted in slackened production.

Kern County Land Company, owner of royalty interest in the Paloma field and 17 other Kern County fields, has estimated that its oil revenues will show a drop of about $500,000 on account of the earthquakes. Last year the company's oil and gas royalties amounted to $18,273,919.

In the Paloma field it was necessary to shut in 96 producing wells when one of the first quakes ruptured a high pressure gas line and ignited the Paloma cycling plant, which normally handled output from the wells. Principal damage at the plant was sustained by storage



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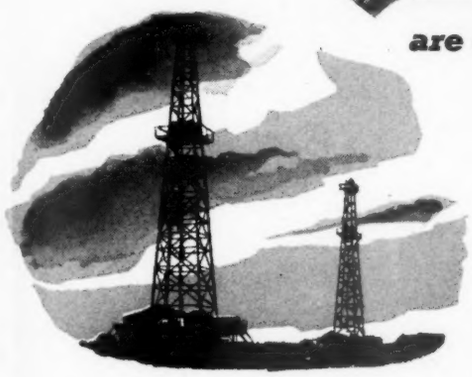
Your Cummins dealer will be glad to tell you more about the exclusive fuel system and other engineering advantages built into every Cummins Diesel. He is an expert who knows the requirements of your job. He heads up a specialized parts and service organization — equipped to handle all your diesel power needs. Call him today... or write!



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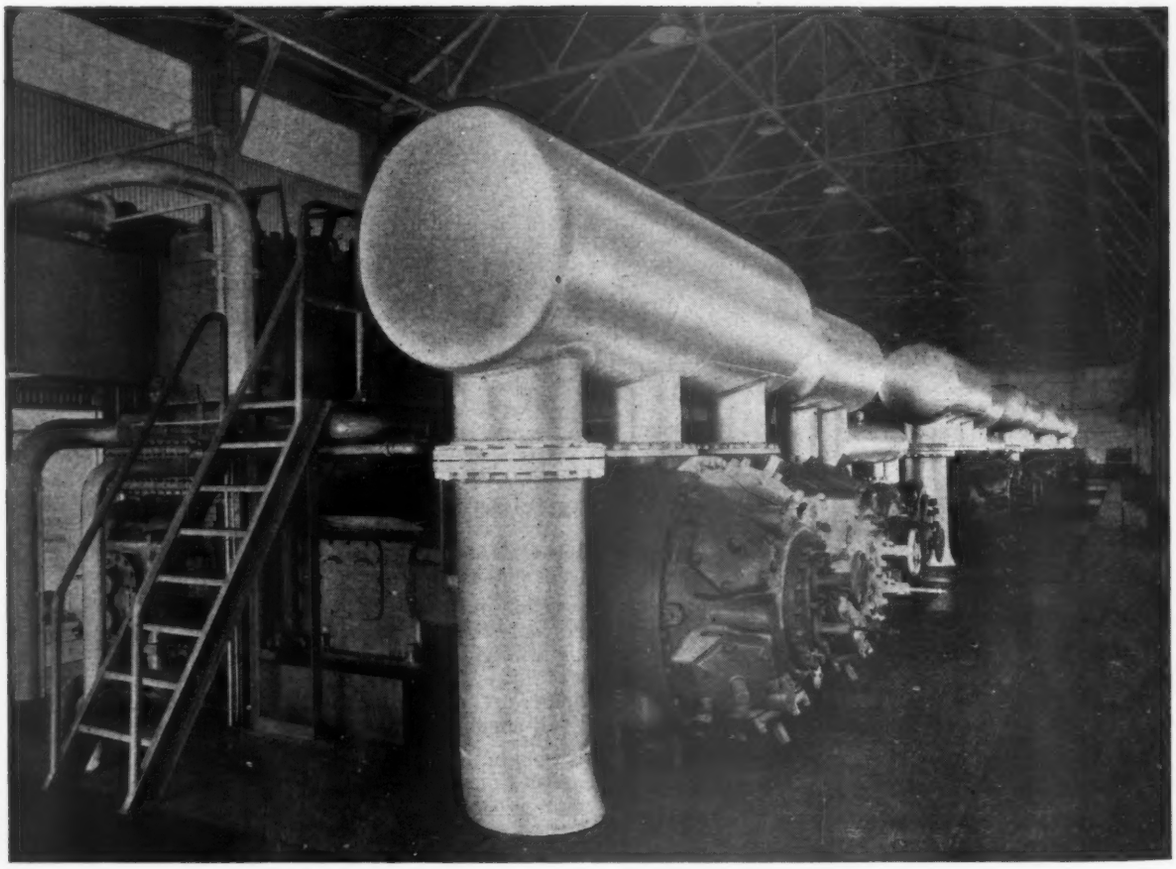
after 7-year struggle with engineering obstacles

Clark Compressors



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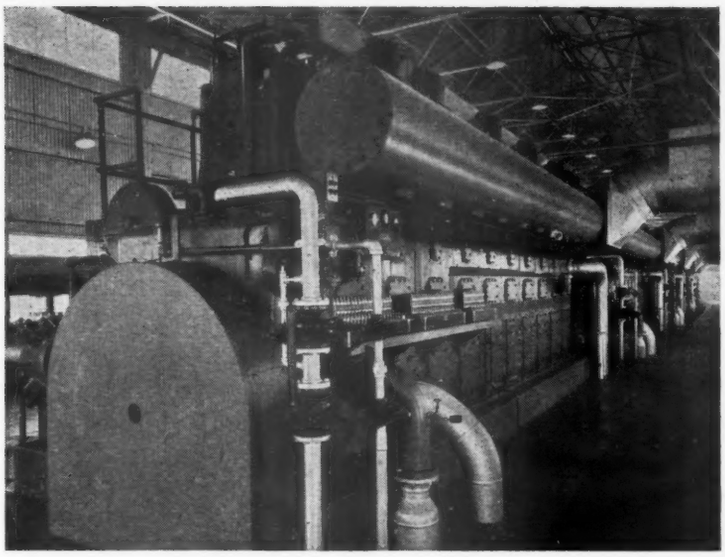

help solve a major problem

Since the development of Ringwood producing field (near Enid, Oklahoma) was begun in 1945, several oil and gas corporations had considered constructing a natural gasoline plant to process this field's gas. It was not until early 1951 that the joint effort of Warren Petroleum Corporation and Oklahoma Natural Gas Company finally resulted in a plan which would justify the present operating facilities.

Design engineers first had to overcome three major obstacles to assure economically sound operations — (1) Shortage of water. (2) Relatively lean gas. (3) Widespread gathering area.

One of the principal problems was compressor selection. Conditions demanded unusually high efficiency and low operating costs. The solution: Five Clark 2500 bhp HLA-10 Gas-Engine-Driven Compressors, the largest available in the world today. The reasons:

- Their high thermal efficiency assured maximum conversion of fuel gas heat value to power, with a minimum rejected to the cooling water.
- Their high compressor cylinder efficiency was essential because of the volume of lean gas to be handled.
- Their greater power packed into fewer units meant less operating personnel.

Now on stream for several months, this unique gasoline plant has already proved the feasibility of operating under these extremely adverse conditions.

For complete information on the Clark Compressors that contributed to its success, write for Bulletin 113.

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CLARK compressors

facilities, cooling towers, laboratory equipment, the compressor building, and the jacket water pump house.

Fire hit five 2500-bbl natural gas and butane storage tanks almost immediately, lighting up the early morning sky for miles around.

Boilers and other refinery equipment were swept off their platforms, either by the earthquake or the resulting series of explosions. Broken fuel lines pressured flaming jets of orange-red fire up into the greasy, sluggish mass of black smoke.

None of the 14 plant employees on duty at the time of the earthquake and fire were injured. Clerks and laboratory men pitched in to fight the flames. About 50 men and 11 pieces of equipment were dispatched to the plant by the Kern County Fire Department.

Something had to give when the earthquake hit shallow wells on Steele Petroleum's Roco lease. Tubing at right was at about 500 ft in one of the wells. Note comparison with joint at left, which was not in the ground.

As soon as the fire was brought under control, repair work began and, as this is written, it appeared as if the plant would be back in operation less than three months after being hit.

Built in 1944 and enlarged two years later, the Paloma cycling plant had a capacity of 60,000,000 cu ft of gas per day. Owners include six majors: Western Gulf Oil Company, Union Oil Company of California, General Petroleum Corporation, The Texas Company, Sunray Oil Corporation, and The Ohio Oil Company.

Many odd phenomena came to light on the heels of the earthquakes.

At the time of the first major quake, Steele Petroleum Company had three 1500-bbl storage tanks sitting side-by-side on a hill. Force of the quake crumpled the middle tank like a paper bag and hurled it down the hill. Neither of the other two tanks in the same battery was seriously damaged.

One of Steele Petroleum Company's wells, Roco No. 30, located several hundred feet from the new well that was ruined, suddenly began to make 34 bbl a day of clean oil instead of the usual 20 bbl. Present production is 24 bbl a day.

While the earthquake was blasting out the 1500-bbl storage tank on the Roco lease, it did not even crack a two-bedroom concrete brick house several hundred feet west of the tank setting.

One well in the Fruitvale field, which formerly produced 40 to 45 bbl daily, jumped up to 75-80 bbl daily after the initial quake. Pressures rose more than 100 lb. Within two days, the well was back to normal—much to the consternation of the operator.

Another company was just as happy to see production drop at its wells. Following one quake, Kern Oil Company, Ltd., found several of its wells in the Race Track Hill field, 10 miles east of Bakersfield, producing at twice their normal rate—roughly 400 bbl daily instead of 200.

Several days later production returned to normal, much to the relief of company officials. Increased production had been found to be virtually all salt water and it simply added to the company's water disposal problem.

In more than one field, fluid slopped out of sump holes. In one sump hole at Fruitvale, where the fluid level was more than four feet below the top of the dirt bank, oily water slopped over the top to soak the ground around the sump.

Perhaps the most awesome moment came in connection with the quake that broke the gas line at the Paloma cycling plant, touching off the costly fire there.

When fire swept the plant immediately after the quake, a giant column of smoke rose into the sky, forming a black "mushroom" which could be seen for miles around.

Some jittery observers were sure they had witnessed the explosion of an atomic bomb and later were vastly relieved to learn that all they had seen was an end result of California's biggest earthquake in 46 years. * * *

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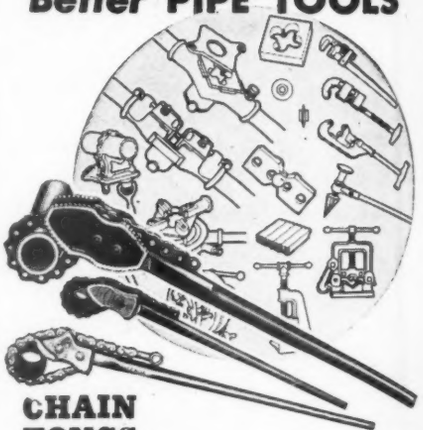
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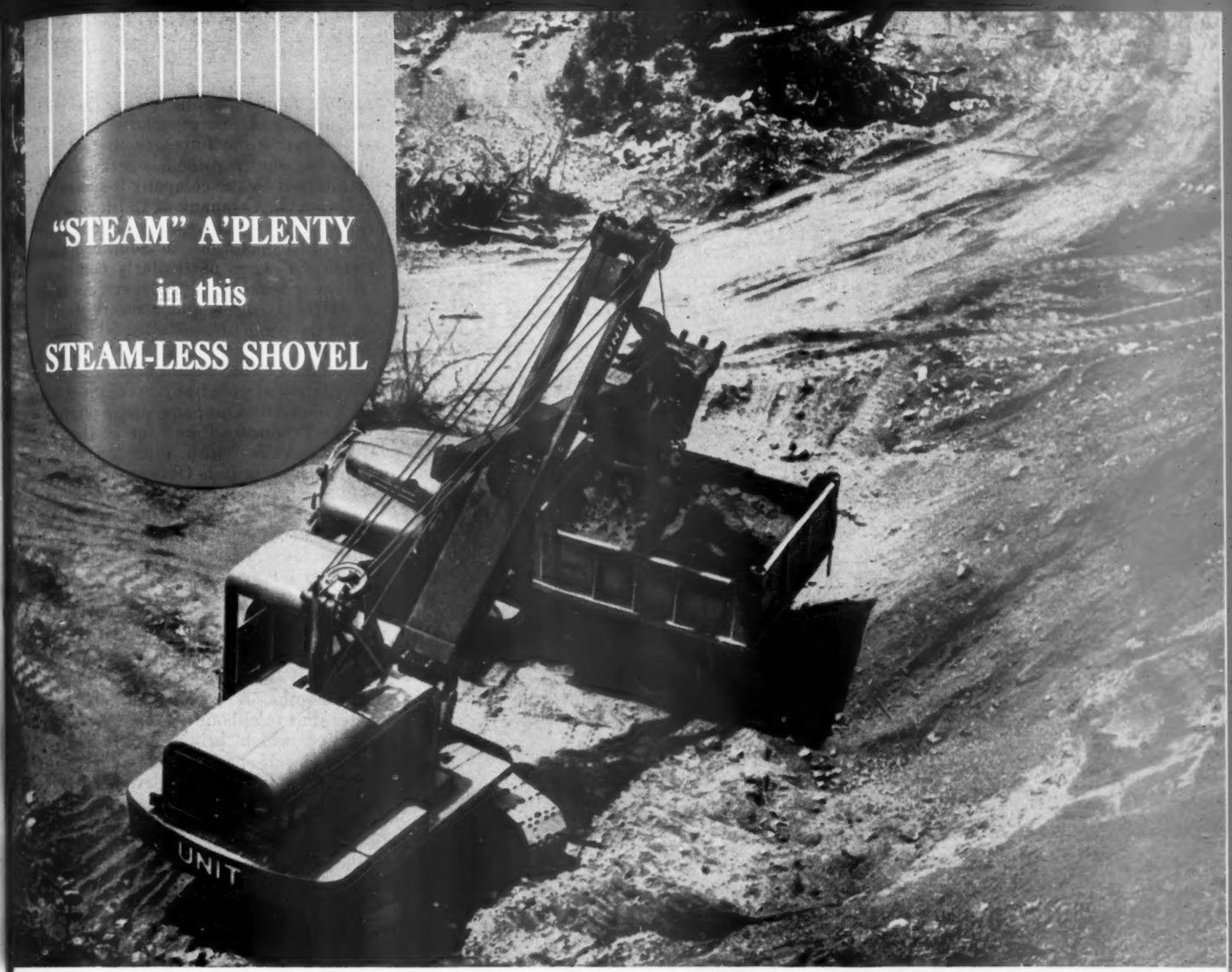

Photo courtesy Unit Crane and Shovel Corporation, Milwaukee, Wisconsin

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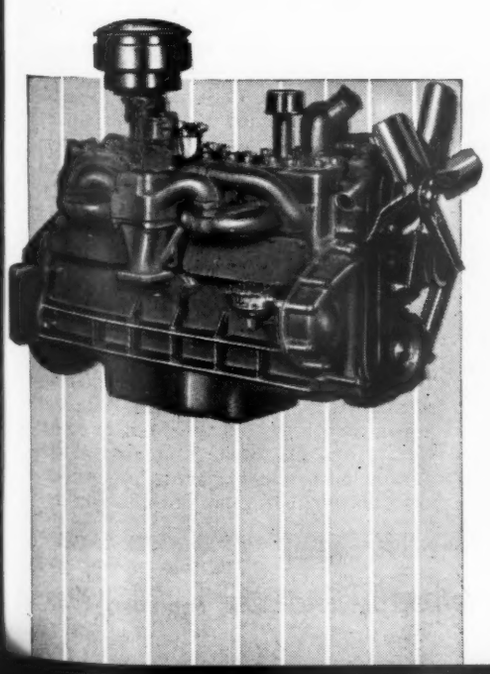

Today, all over the country, gasoline-powered versions of the old steam shovel are piling up record after record for volume output, speed and economy of operation.

In the vanguard of modern earth-moving equipment is Unit's model 614 one-half yard shovel, powered by the Chrysler Model 16 Industrial Engine and featuring the Chrysler torque converter as standard equipment. Unit operators find this an ideal combination since, in giving them fast, dependable power without risk of stalling, work output is *increased* while fuel consumption is actually *decreased*. Moreover, the smooth application of power through the torque converter eliminates shock loads to engine and equipment, thereby reducing maintenance costs.

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Drilling foreman, K. W. Brown, finds the two-way radio invaluable in his field contacts.

Communications Evolution

Scattered operations of Union of California are linked by effective automatic telephone system

RICHARD SNEDDON*

In order to coordinate the scattered operations of any large institution, it is essential that all related departments be within easy and quick conversational reach of each other. Thus, the rapid development of the petroleum industry has been paralleled all along the way by a similarly interesting evolution of the communications system.

For at least the first 17 years of its existence, the oil business had to depend almost solely on human carriers for the transmission of messages from one area to another; but with the invention of the telephone in 1876, a new era began. It would be difficult now to say to what extent the actual expansion of the industry has been due to the greater facility with which people in different areas could thereafter discuss their respective but interdependent interests and activities. There is no doubt, however, that in many businesses this ease of communication has played a considerable role in the integration of departmental activities and consequently the more economical conduct of the total operation.

In telephone communication, specifically, there have in recent years been modifications and adaptations of method that have made the system more effective than ever. Particularly is this true in the matter of eliminating manual controls and substituting practically complete automatic operation. Automatic operation is, of course, not new; but modern refinements have succeeded in making it more applicable to the modern need, and one especially attractive aspect is that the automatic system may now be wholly owned, operated, and maintained by the company it serves.

Union Oil Company of California, because of its widely scattered and much diversified operations in Southern California, has been particularly communications conscious over the years. As early as 1888, Hardison and Stewart, founders of the company, installed 50 miles of telephone lines and 16 instruments in the Santa Paula-Ventura area. The later installation of pole lines interconnecting all Union Oil Company pump stations on the Producers Pipe Line in the San Joaquin Valley with pipe line headquarters at San Luis Obispo and Orcutt, and the marine terminal at Avila, instituted a tremendous saving of time and money, and in much improved form, is still performing admirably.

In the Los Angeles basin area where the field stations and head office have for many years been on the same sort of interconnecting hookup as that employed in the San Joaquin Valley, a consequential change has been made in recent months. A new completely automatic dial telephone system* has been installed which brings together in a series of self-operating exchanges, the head office in Los Angeles, the Petroleum Building, also in the city, Santa Fe Springs, Whittier, Dominquez, Brea Research Center, and the refinery at Wilmington. The new set up consists of sixty-six major circuits, 2502 miles of voice channels, seven new automatic exchanges, a number of manual type switch boards—adapted to automatic operation—and 1150 telephone instruments.

This southern system also provides manual interconnection with Bakersfield, San Luis Obispo, and Orcutt in the northern and coastal divisions, and brings the administrative and operating people over the entire system, many of them working over 300 miles apart, into a hypothetically compact grouping in which they can discuss mutual interests at any instant and for any length of time without worrying about long distance toll costs or fellow subscribers.

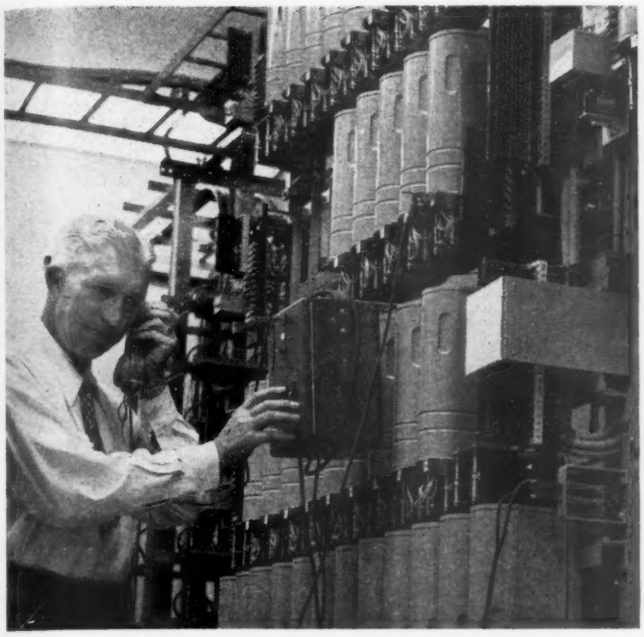
The need for something more effective than the existing system was first seriously recognized in 1946, and at that time comprehensive engineering studies of the need were undertaken. As a result, it was decided that the company could install its own automatic system at a saving of $200,000 annually, and since estimated equipment and installation costs approximated $750,000, could amortize the entire investment comfortably within four years. Meantime, the company could also obtain better services for its particular purposes.

Installation was begun in 1949 with the involved area amounting to about 1600 square miles and extending, as indicated, from Los Angeles to Wilmington in the south, and then east to Santa Fe Springs and Brea. A number of important oil producing areas, a considerable network of pipe lines, major re-

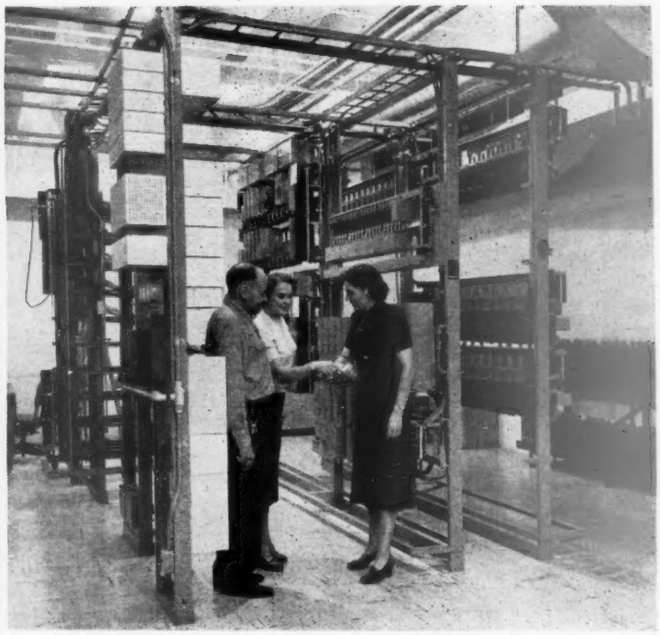
*Pacific Coast editor.

*PAX Business Telephone System, Automatic Electric Company.

EXCLUSIVE



This is a part of the complex intercommunications system with Foreman Ernest Cheatham doing a bit of checking up.



Albert Cluster, long time communications trouble shooter, gives a few pointers on the new system to Florence Myers and Ruth Diehl at Brea.

finery facilities, a marine terminal, a large modern research center, and important administrative and operative departments, lie within the periphery of the total affected area.

Six individual but interconnected automatic switchboards were required to give adequate service to all stations and departments. These were situated as follows: (1) in the Los Angeles head office, a 300 line unit; (2) southwest territory marketing office in Los Angeles, a 60 line unit; (3) refinery and marine terminal at Wilmington, a 400 line unit; (4) pipe line and field department offices at Santa Fe Springs, a 200 line unit; (5) research center at Brea, a 200 line unit; (6) field offices at Dominquez, a 100 line unit. This makes an extensive and comprehensive interconnected network in which any individual in any part of the system may at any time dial directly any individual in any other part of the system.

Through a manual switchboard, this network is also connected to the telephone system in the northern division. An automatic system has also been installed in the Oleum refinery, near San Francisco; and although this is not at the moment tied in with the other two general divisions, there is little doubt that it will eventually be integrated into the overall system.

The combination of telephone circuits now employed by Union indicates the adaptability of the automatic system. It appears to be able to utilize any type of communication channel either for station-to-station lines, or for trunks between exchanges. The common method of supporting telephone wires on properly spaced poles is to some extent amplified by the use of carrier channels. Utilizing the necessary carrier equipment, it is possible to make each pair of wires carry a number of calls simultaneously. In addition, where necessary, supplementary circuits are leased from the telegraph company.

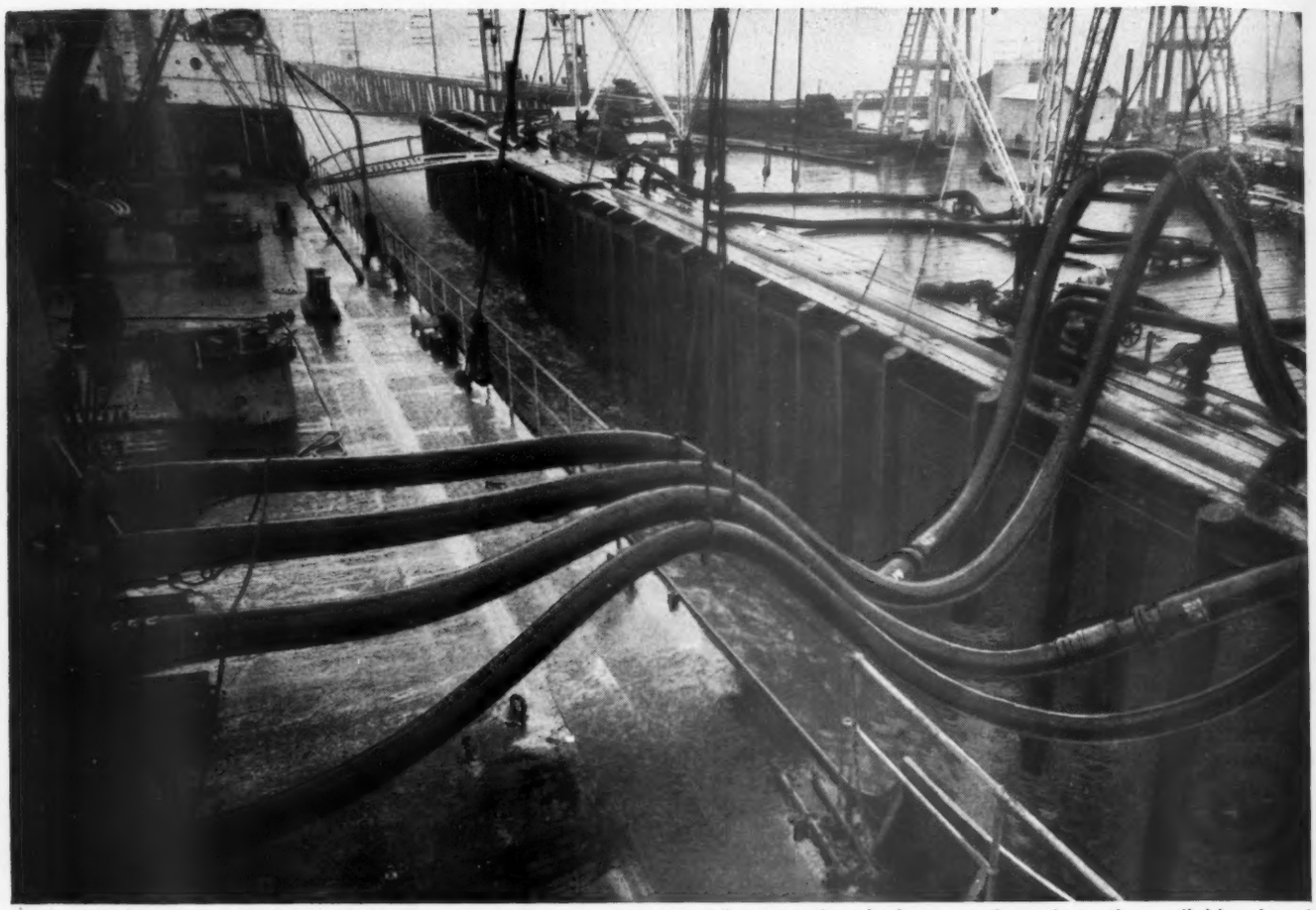
A great aid toward still higher communications efficiency is the radio equipped automobile through which key men, while riding, can be contacted via the main switchboard by any station on the line, or can contact each other when that becomes necessary. These radio cars effect substantial time savings and offer a medium that has already well demonstrated its value under almost any type of emergency situation. Its usefulness, in case of accident, fire, equipment failure, or other such undesirable contingency, is obvious.

Orcutt district office in which the two-way radio cars and the regular telephone service are interconnected. Handling the cross-over is Martha Hodges.

The entire automatic system as planned by Union Oil Company, is designed to permit expansion, adaptation, or interchange of the essential equipment at any time it is deemed advisable. Most of the switching equipment is readily interchangeable, and the unit type switchboard that has been used at the Southern Territory office was chosen because the need at that location for further lines is at present remote. Should the situation change, however, it would be a comparatively simple matter to replace this board with an expansible switchboard of the same type as those installed at other terminals.

The elasticity of the total set-up is illustrated by the fact that when field operation headquarters were moved from Santa Fe Springs to Whittier some time ago, the sixty line switchboard that had served Whittier was laid aside as a future supplement to communication needs in

XUM



Tanker docks operate day and night; they depend on company-owned automatic telephone service—instantly available always!

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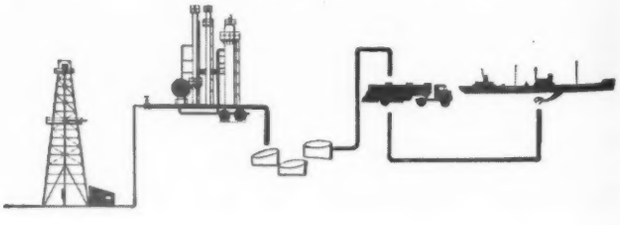
At dockside . . . in the drilling field . . . throughout widely separated areas where crude oil is processed into finished products — Union Oil Company's P-A-X Business Telephone System keeps hundreds of miles of Oil operations under control twenty-four hours a day.

Automatic, *company-owned* P-A-X telephone facilities speed work in Union Oil's Southern Division, step up economies and convenience in all operations. This widespread network of telephone communications links *all* levels of management to *all* company locations throughout the division.

P-A-X is job-designed for oil companies

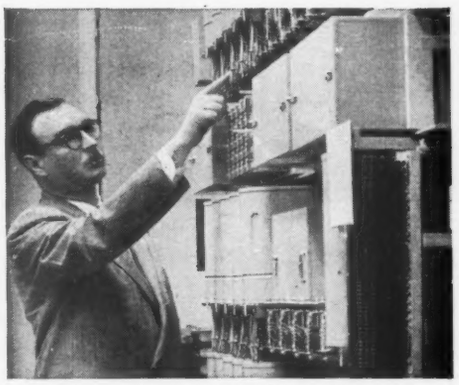
Scores of oil companies have used speedy P-A-X Systems to improve refining operations — control pipeline flow — tighten administration — tie all operations together in a unified communications system. P-A-X telephones, switchboards and circuits meet the most exacting control needs of the oil industry.

P-A-X is a system of "inside" telephones, separate from the public telephone system, and owned by the user. It is completely automatic and establishes all "inside" calls within seconds, at any time! P-A-X service permits marked economies in rental of city equipment. Manufactured by Automatic Electric, the originator of the automatic telephone, P-A-X telephones and switchboards are equal in quality to the finest equipment anywhere!



Union Oil's 1200 miles of pipe lines transport 70,000,000 barrels annually. Pipelines converge at storage tanks and pump stations. Each control point is equipped with a P-A-X telephone.

George Robertson, Maintenance Engineer, with Lenkurt Carrier equipment which permits each pair of wires to carry several calls simultaneously.



Fred Broughton, Union Oil's Communications Engineer responsible for planning the P-A-X Telephone System with the General Office switching equipment.

Control room of Union's large modern refinery at Wilmington. Operators receive P-A-X telephoned instructions to adjust the controls. P-A-X telephones give the Pump House Dispatcher precise control of oil flow.

Interested in more information? This comprehensive booklet—a case study of Union Oil communications—is yours for the asking. Detailed facts are presented in 12 abundantly illustrated pages. Write for your copy today!

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Union Oil Company coordinates widespread operations with its own telephone system

Union Oil Company of California—largest and oldest "independent" in the West—has 2,000 wells pumping from 600,000,000 barrels of reserves. Union's 1,200 miles of pipe lines transport 70,000,000 barrels annually and its fleet of seven oil tankers transports oil and derived products regularly to South America, Hawaii, Alaska, and ports in other far-flung places.

Distance and dispersal—coupled with the necessity for split-second coordination—created difficult communication problems. Union Oil solved these problems with uninterrupted "private-wire" P-A-X telephone communications, engineered to allow for unlimited expansion. Today, the company saves dollars and time and resolves formidable problems of distance with its own telephone system. Since its new telephone system was "cut in", Union Oil personnel make more than 11,000 calls each day.

Several different types of circuits are used by Union Oil to complete their trunk line system. These include wire, phantom and carrier circuits. Through use of carrier equipment, a single pair of telephone wires carry a number of

Reporting work progress on Field Dispatcher's telephone.

telephone calls simultaneously—an easy way to expand a telephone system without large investment in physical lines or use of critical materials. The carrier equipment is Lenkurt Carrier, engineered and installed by Automatic Electric as an integral part of the over-all communications system.

The P-A-X network provides a complete communications "package" that controls every operation from the pumping of crude oil to final distribution of refinery products. This system is company-owned, -operated-and-maintained. Management has complete freedom in adapting its own telephone network to the ever-changing, greatly increasing demands of its extensive and complex oil operations.

George Robertson is here pointing out the carrier equipment by means of which each pair of wires can carry a number of calls simultaneously.

A single switchboard to the left, operated by Jewell Schmidt, handles all in and out of the Los Angeles area.

San Francisco, and a 200-line board was installed for the Whittier area. Similarly, when immediately after the completion of the Brea Research Center, it was found that telephone facilities were inadequate, a section of switching equipment was temporarily moved in from Dominquez. This was accomplished in a few hours and without the necessity of purchasing any new equipment.

An attractive feature of the automatic system is that all service is continuous, regardless of staff working hours. There is no waiting for connections, no long distance charges—hence no accounting records of calls and their costs, and to top it all off there is no time limitation on calls. The system is ideal for executives who, from home office headquarters, can dial any key point or key person in the Southern Division, and get immediate response. It simplifies, too, the matter of consultation between field foreman and technicians, and the superintendents to whom they are responsible.

One of the important daily tasks of the field supervisor is to make a complete accounting of the accomplishments of his department for the preceding twenty-four hours. This, of course, applies to all operating areas, and in a concern of the dimensions of Union Oil Company, builds up to a sizable operation in itself. From this information is made up a daily field report that gives the current status, for example, of every drilling well or projected drilling well, from location to completion, in which the company is concerned. It also contains all the incidental details that are of interest, and becomes the basis of many important telephonic conferences and consultations. Needless to say, the automatic system has facilitated, expedited, and economized this data gathering process in a marked way, and field men and executives alike declare their gratification.

Another interesting department in which the automatic telephone system is particularly advantageous is pipe lines. Anyone familiar with dispatching system employed in a modern pipe line office will realize at once the benefits that are bound to accrue from a self-operating communications system. The normal function of the dispatching department is to control all movements of oil from the time it is produced at the well until it is received at the refinery or terminal. It is, in actuality, the voice of the pipe line superintendent, and it receives hourly reports of every oil transfer within these limits once an hour. It receives such reports in the utmost detail, including in and out gages, line pressures, pump speeds, and a multitude of similarly pertinent data. It issues the official orders for the execution of all oil movements within its jurisdiction, receives notice of their completion, and is the clearing house for every bit of consequential information developing in any part of the field.

The dispatching department is on the phone twenty-four hours out of every day and almost continuously throughout that time. It is easy to understand, thus, why the pipe line people are more than pleased with automatic communication. It is a real time saver. It gives the dispatcher a chance to take the head phones off occasionally and allow his ears to grow in unrestrained normality. It speeds up the regular gaging and pumping operations, and provides faster reports on emergency developments. It assures an immediate contact for the direction of repair crews; for the receipt of progress reports on repair work; and for the completion of commodity changes in the lines with the least possible admixture.

Advantages at refineries and terminals are just as tangible. The receipt of crude oil at, and the shipment of refined products from the former, are subject to timing and general control by telephone. Twelve automatic phones connect the main pump house at the refinery with the marine terminal at Wilmington. By means of these, pumpings are more tightly controlled than has been possible hitherto; and the operations can be intimately discussed at any time by the port captain, the marine department, the pipe line dispatcher, and the head office representative. Connections are always surer and quicker, and that makes for better coordination which in turn assures a top job in the minimum of time.

Mention has been made of accidents, fires, and catastrophes of various sorts; and it can be well imagined what a self-operating, company owned, communication system would mean during any such emergency. In the case of a severe earthquake, for example, it would permit the immediate check, without outside interference, of all facilities to determine the damage, if any. Should there be any damage, it would permit the correlation and direction of remedial and defensive measures, rescue work, fire control, and any other efforts that might be considered necessary for the protection of people and property.

There are many other departments and departures in which the automatic telephone system has demonstrated its effectiveness, but it is hardly necessary to go further. It is all a part of the in-

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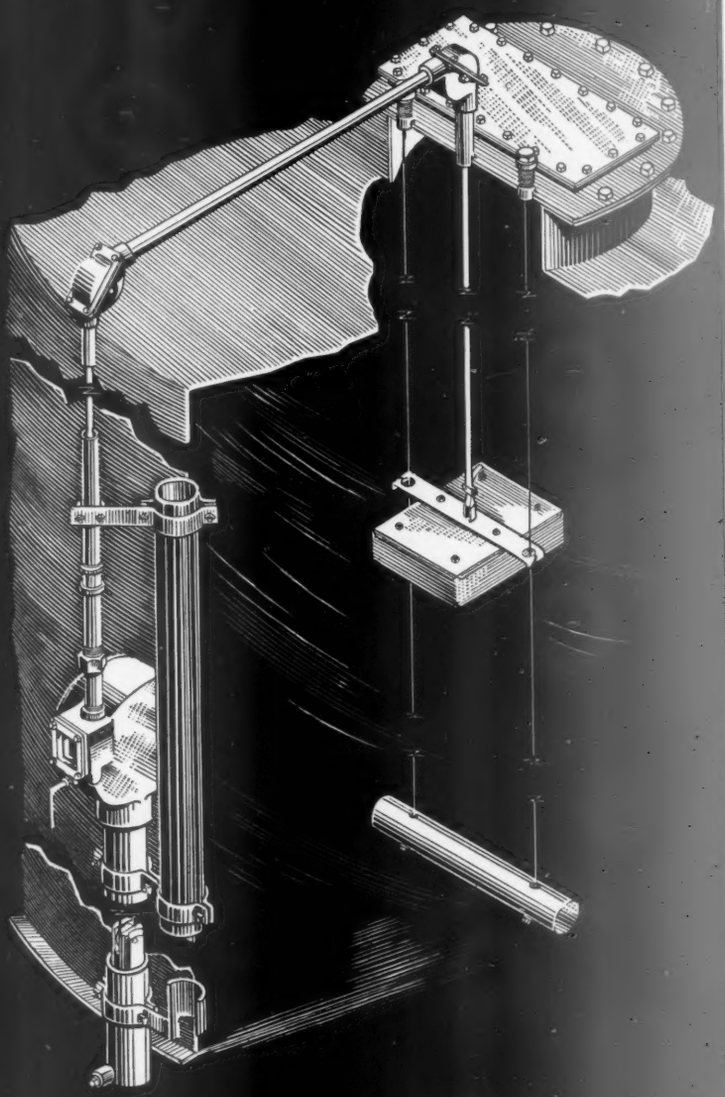

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In the picture above, a new E-M Weather-Protected Squirrel-Cage Induction Motor for outdoor installation is being subjected to a deluge test. Two streams of water at 75 psi are spotted to blast hood and baffles. Inspection after test showed rotor, coils, and core to be completely dry . . . and the motor was belt-driven cold so that no quick evaporation took place.

Putting them OUTDOORS or

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Indoors or out, E-M's new large squirrel-cage induction motors will give you something "extra" in appearance, durability, and reliability on your large high speed drives.

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4. LONG LIFE STATOR COILS . . . Stator coils, preformed to fit core slots accurately, have insulation engineered for the application. Leads are carefully bound and sealed. Coil ends are tightly lashed to each other and to heavy bracing rings to prevent distortion on full-voltage starting.

Exterior of new E-M Weather-Protected Squirrel-Cage Induction Motor, designed to provide dependable outdoor service under the most rigorous weather conditions.

Bracket-Bearing E-M Two-Pole Squirrel-Cage Induction Motor uses contoured frame and oil pump enclosure for trim appearance. Forced ventilation system with intake and discharge through base.

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For specific details that will pertain to your own requirements, consult your nearest E-M sales engineer. And write the factory for E-M Synchronizer No. 34 and Foto-Facts No. 21, describing what's new and important in the design of large induction motors.

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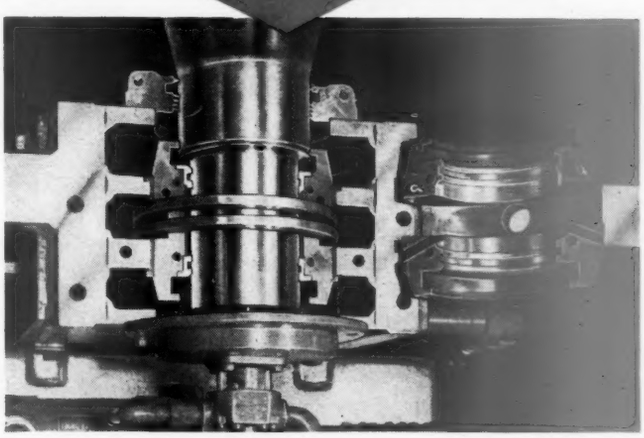

Section of sleeve-type bearing, showing journal, oil rings, linings, and "aerodynamic" pressure seal to eliminate oil vapor leakage.

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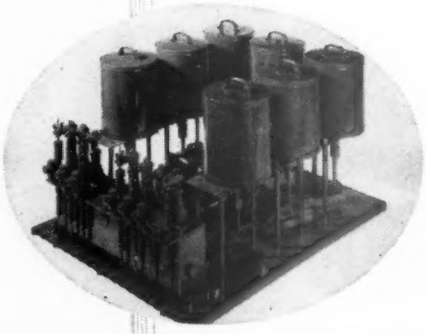

MULTI-FEED CHEMICAL FEEDERS

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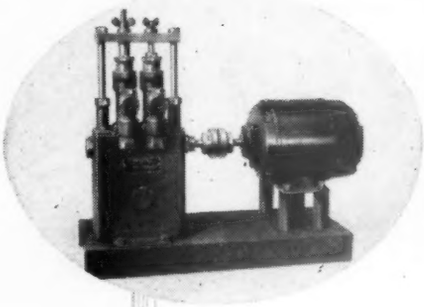

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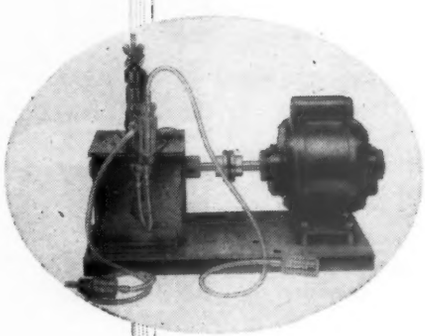

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exorable march of science. Keeping the entire system in shape are seven operations and maintenance men who work under the direction of a communications engineer and two communications foremen. Plans for the future contemplate extension of the automatic system into the other divisions not now equipped, and the eventual inclusion of micro-wave (beamed, high-frequency radio) to furnish additional channels.

In Orcutt, as already mentioned, there are now seven cars equipped with radio. Ten more are being readied for the Bakersfield area, and seven are already tied into the Santa Paula system. These radio equipped cars are rapidly becoming regular field equipment in all operating phases of the petroleum business. They are, in effect, extensions of the communications system into otherwise inaccessible but highly important areas, and they are performing a very worthwhile function in the new order of things. In these auxiliary mobile units and the automatic telephonic system, we have about as effective a communications combination as one could desire even for these ultra-scientific times. Its appeal lies not only in effectiveness and low cost, but in the less tangible virtues of convenience and outright ownership.

Convenience is expressed in the ease and satisfaction of quick accomplishment. When the entire Union Oil Company territory is hooked up under the automatic communications system, as it very likely will be one day in the future, it will merely be necessary for the head office executive or staff member to dial the right number and immediately be in touch with the most remote area in the entire company operations. That will bind the widely scattered organization into an even more closely coordinated and integrated entity than it is now, which in the long run, means more efficient organization and more effective production.

As for outright ownership, that begets a sort of possessive pride which just naturally stimulates the inventive yen, and speeds up system improvement. And if that is too intangible to be seriously regarded as a favorable feature, remember that if the system should ever be crippled by a common disaster, it won't be necessary to await the arrival of outside trouble shooters to get things back in shape again. The regular company communications maintenance and repair crew will be able to restore the service or, at the very worst, direct its restoration.

In any case, it is quite certain that since Union Oil Company's new automatic communications system was initiated in May, 1951, the improvement has been marked. With gratifying ease and considerable saving of time, employees are now making over 1100 calls a day—many more than was estimated when the system was planned. The communications network is functioning splendidly, and further similar adaptations and additions, projected for the near future, are proof enough that management, too, has found satisfaction in the communications modernization program. * * *

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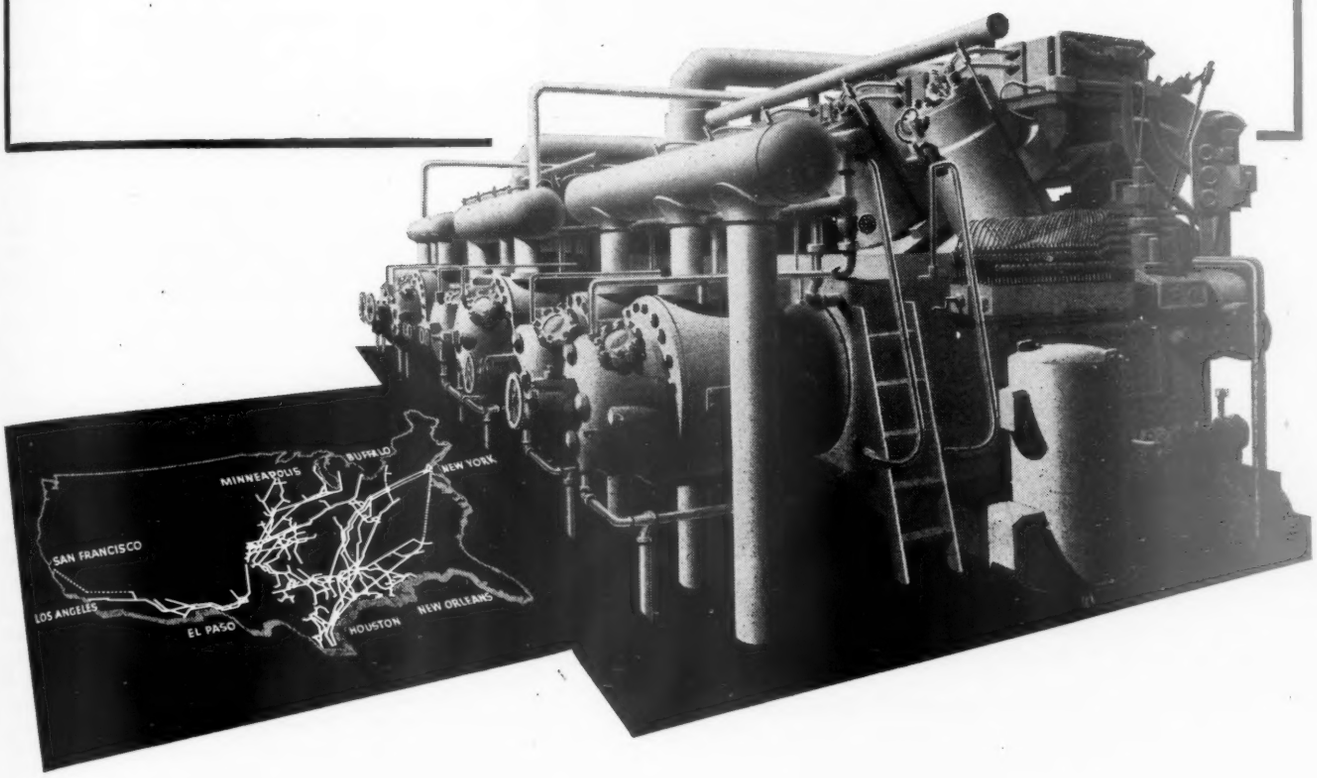
helps prevent operating troubles



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GULF INDUSTRIAL LUBRICATION

Petroleum Profile

W. M. V. ASH

President

Shell of Canada

W. M. V. ASH, president of Shell of Canada, is a good example of the itinerant oilman, having served with the Shell Group over the past 23 years in at least eight different countries of the world.

Vacy Ash was born in Dunfermline, Scotland, where his father practised medicine, and obtained his early education at Glenalmond College, in the Scottish Highlands. Following matriculation he attended Grenoble University in France for a special course. Today he looks back with much satisfaction on the time spent at Grenoble. Canada is a bilingual country, and in many areas French is spoken exclusively; Ash can talk to employees, dealers, or customers in their own language.

From Grenoble, Ash returned to the United Kingdom and commenced the study of law at Oxford University, from which he graduated in 1929 with a Master's degree. While studying at Oxford he became interested in the international character of the oil business, and on graduation joined the Shell Group of Companies with which he has been associated ever since.

Ash's early days in oil gave him a varied experience in its production and marketing. Shortly after joining Shell he was sent to the Near East, and for a period of 8 years held increasingly responsible positions in Egypt, Palestine, Arabia, and other Middle Eastern countries.

"Those were exciting days," Ash recalled. "This was a period of great growth for the oil industry. Competition was intense and the struggle for crude oil and markets keen and stimulating."

In 1937 Ash was appointed assistant to the vice president in charge of Shell's production in California. From 1937 to 1941 he was one of Shell's Los Angeles team, which administered the production activities of the company in the California oil fields. During his time there, several of the great new fields of the San Joaquin Valley were brought into full production, and he likes to recall the hectic days when the many oil companies vied for acreage in this important area.

Ash was appointed executive assistant to the president, Shell Oil Company, New York, in 1941 and a year later came to Canada as general manager, Shell Exploration Alberta Ltd. There, near Calgary, the great Jumping Pound gas field was discovered and shut in, awaiting the development of markets. In the last two years Ash has officiated at the opening of his company's gas and sulfur plants at Jumping Pound, the latter Canada's first plant for the extraction of sulfur from natural gas. He commented on the satisfaction he felt in having seen this area progress from the ranch lands of his early days to a modern industrial site.

Returning to New York in 1944, Ash became a member of the Supplies Subcommittee of the Petroleum Administration for War. Following this appointment he was posted to the West Indies as general manager of United British Oilfields of Trinidad, Ltd., and held this position from 1945 to 1948. Early in his service there, his gift for administration was recognized, and he was elected president of the Petroleum Association of Trinidad. Shortly after, the Governor of the Island nominated him a member of the Legislative Council where his enterprise and imagination could be put to good use in the conduct of the Island's affairs.

In 1948 Ash returned to Canada as president of Shell Oil Company of Canada, Ltd., which position he holds today. Extensive and diversified experience in the oil business well equips Ash to handle his company's interests in the booming Canadian economy. Canada is experiencing unprecedented industrial expansion, and Ash heads up the team that sees that Shell keeps pace. Two new refineries, the first direct oil company chemical plant in Canada, the first petroleum sulfur plant, Shell's major part in three great new Canadian pipe lines, together with notable increases in Shell's Canadian trade, and other achievements, all testify to the success of the team.

Though administering the affairs of his firm over an extensive territory, Ash still finds time to lend his talents to religious, educational, and civic activities. He is a member of the executive of the Anglican Church, a member of the Board of Governors of one of Canada's largest independent schools, and a vice president and director of the Ontario Safety League.

A keen sportsman, Ash enjoys shooting and fly fishing. He denies, with a twinkle, that the route of the Trans Mountain Pipe Line, through some of the finest trout-fishing country in the world, was in any way a factor in Shell's participation in this great project.

Salutations to Canada

Canada in 1953 will in all probability become the third largest oil producing country in the western hemisphere. Presently the USA leads, and Venezuela and Mexico follow.

This issue is devoted to Canadian oil operations. From it one may obtain a glimpse at the magnitude of Canada's expanding industry. Historically, Canada is an old oil-producing country. The first oil well was drilled in Canada in 1858 in the county of Lambton, Ontario, a year before the famous Colonel Drake discovery in Pennsylvania, USA. Its prominence as a large producer, however, began in 1947 when Imperial Oil, Ltd., discovered the Leduc field.

The bulk, 99 per cent, of the production at the moment comes from the Province of Alberta, which is in the west. It is in Western Canada that a vast sedimentary basin of some 500,000,000 acres is found and whose productive limits are far from final determination. In consequence a large exploratory campaign is under way and is increasing monthly.

Records were broken in 1952. There was a total of 180 discoveries in Western Canada, 93 oil, 69 dry gas, and 18 wet gas. Alberta had 65 per cent of this total. Saskatchewan had 30 wildcat strikes, 23 oil and 7 gas. British Columbia had 11 new finds, 5 oil and 6 gas. In Canada's Williston Basin 4 wells came in as producers of light gravity oil.

On January 1, 1953, there were 275 rotary rigs throughout Canada, 226 of them active. Of the active rigs, 108 were moving to or were at wildcat locations; the rest were on development locations (only 20 rigs were active in 1947). Alberta is again the area of concentration and 107 rigs drilled 1573 wells, of which 513 were dry holes, for a total footage of 6,500,000 ft. This was an increase of 16 per cent over 1951. In Saskatchewan 36 rigs were operating, 12 in British Columbia, and 8 in Manitoba.

The record number of geophysical crews in the field was 185, and on January 1, 1953, there were 168 (in 1947 there were only 15 crews). Alberta experienced the greatest activity with 120 seismic and 7 gravity crews. In Saskatchewan there are 29 seismic and 2 gravity, Manitoba 3 seismic, British Columbia 6 seismic, and 1 air magnetometer.

Production was increased by more than 37,000 bbl per day and the daily average for 1952 was 180,170 bbl oil; a total of 93 billion cubic feet of natural gas was produced. Proved recoverable oil reserves were increased to almost 2 billion barrels, and gas to 10,500 billion cubic feet. Canada's oil and gas reserves are increasing steadily each year.

The Peace River district that encompasses portions of British Columbia and Alberta looms as a great potential gas area. Much attention was focused upon the area in 1952 and engineers forecast a reserve of 3 trillion cubic feet of gas. It could be called an "area of promise," and intensive drilling may develop. The possibility of intensive drilling activity is emphasized by the fact that the enormous Peace River reserves are close to the Westcoast Transmission pipe line that is proposed for completion late this year.

During 1952 it is estimated that $250,000,000 was expended on land purchases, exploration, and operational expenses. In 1953 the appropriation is likely to be $400,000,000. This almost doubling of the outlay can be considered as a healthy sign, to say the least, and by it can be judged the expansion program that is anticipated during the coming year.

Although considerable capital has been invested in Canada's oil, and moreover continues to be poured in, it is essential then that operators have a feeling of security in the risk of their ventures. This can be summarized best with a quotation by W. M. V. Ash, president, Shell Oil Company of Canada. He aptly stated in an address before the Eighty-first Annual General Meeting of the Canadian Manufacturers Association on May 28, 1952, at Toronto:

> "Traditionally the attributes of a great producing country are counted as the existence of the natural resources, of a favorable and stable governmental atmosphere, and of skilled and intelligent manpower. All these we have in Canada — what is there to stop us?"

The success that has been achieved by the Canadian oil industry is mighty by any standards. The industry, however, is not content to rest upon its hard won laurels, instead it desires to expand. For its past efforts, the present accomplishments, and to its future oil field development, salutations to Canada and its petroleum industry.—J. M.

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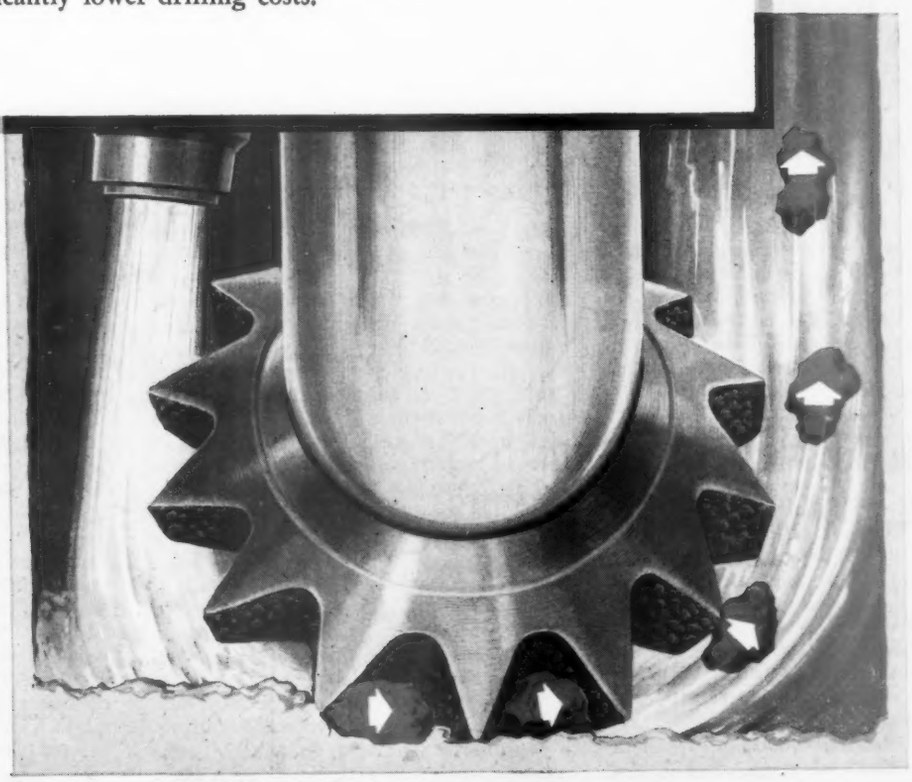
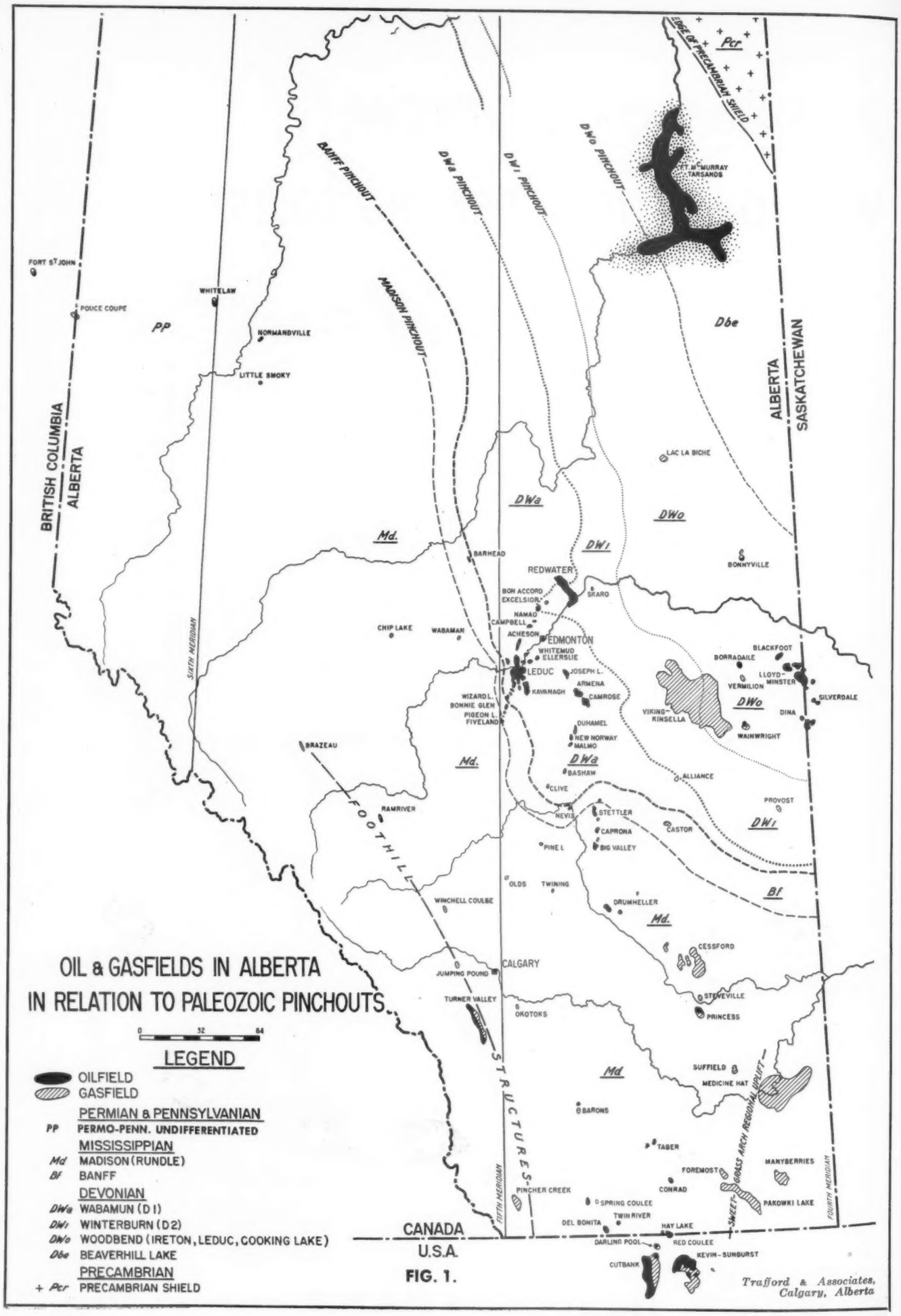


ROLLER BIT COMPANY HOUSTON 1, TEXAS


EDGE OF PRECAMBRIAN SHIELD
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NORMANDVILLE
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ALLIANCE
NEVIS
STETTLER
CAPRONA
BIG VALLEY
CASTOR
PROVOST
PINE L
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TWINING
WINCHELL COULEE
DRUMHELLER
Bf
CESSFORD
CALGARY
JUMPING POUND
TURNER VALLEY
OKOTOKS
STEVEVILLE
PRINCESS
SUFFIELD
MEDICINE HAT
BARONS
TABER
FOREMOST
MANYBERRIES
PINCHER CREEK
CONRAD
SPRING COULEE
PAKOWKI LAKE
TWIN RIVER
DEL BONITA
HAY LAKE
DARLING POOL
RED COULEE
KEVIN-SUNBURST
CUTBANK
BLACKFOOT
BORRADAILE
LLOYD-MINSTER
VERMILION
SILVERDALE
VIKING-KINSELLA
DINA
WAINWRIGHT
SIXTH MERIDIAN
FIFTH MERIDIAN
FOURTH MERIDIAN
STRUCTURES
SWEET GRASS ARCH REGIONAL UPLIFT
OIL & GASFIELDS IN ALBERTA
IN RELATION TO PALEOZOIC PINCHOUTS
0 32 64
LEGEND
OILFIELD
GASFIELD
PERMIAN & PENNSYLVANIAN
PP PERMO-PENN. UNDIFFERENTIATED
MISSISSIPPIAN
Md MADISON (RUNDLE)
Bf BANFF
DEVONIAN
DWa WABAMUN (D1)
DWI WINTERBURN (D2)
DWo WOODBEND (IRETON, LEDUC, COOKING LAKE)
Dbe BEAVERHILL LAKE
PRECAMBRIAN
+ Pcr PRECAMBRIAN SHIELD
CANADA
U.S.A.
Trafford & Associates,
Calgary, Alberta

FIG. 1.

Basal Lower Cretaceous Accumulations in Alberta With Special Reference to the Campbell Pool†

Do these shallow reservoirs point to the occurrence of Paleozoic production in deeper strata in their immediate neighborhood?

P. KLAUI

THE Athabasca Tar Sands of Lower Cretaceous age outcropping along the Athabasca River in Northern Alberta are the largest known oil reserves in the world. They have been estimated to contain more than one hundred billion barrels of oil and led the early geologists to the belief that these tar sands were not the only occurrence of oil in the province, but that more oil would be found in the large sedimentary basin, which covers the southwestern part of Manitoba, Southern Saskatchewan, most of Alberta, northeastern British Columbia, and extends in a northwestern direction through the Northwest Territories up into Alaska. Their theory led to the search for oil in Western Canada and finally after many years of disappointment or limited success resulted in the spectacular discoveries of the Alberta oilfields during recent years.

Besides these huge reserves, oil and gas accumulations have also been found to occur in many parts of the province in commercial but more often in non-commercial quantities in sands of Lower Cretaceous age resting upon the eroded surface of Paleozoic formations, along a widespread major unconformity.

Since the discovery of the Leduc field in February 1947, most of the major oil discoveries were made in coral reef reservoirs of Upper Devonian age. These Devonian reservoirs were found to contain such large reserves of oil and gas that they dwarfed all previous discoveries. As a result most of the oil companies have made Devonian reef structures their main objective. Consequently, many geologists have become particularly reef conscious or even "reef happy" in their search for oil.

It is, therefore, not surprising that the Lower Cretaceous accumulations have lost the interest of many oil companies as they are less prolific, often difficult to produce, and therefore are considered to be of minor importance.

Some rather recent developments in Alberta, but mainly in British Columbia (Fort St. John area), and Saskatchewan (Fosterton area), however, prove that these Lower Cretaceous accumulations can be of major importance as they may open up the oil and gas possibilities in areas that hitherto were believed to be barren.

Another factor, which may be of importance, is that some geologists believe that these Lower Cretaceous accumulations may have derived their hydrocarbon contents from the unconformably underlying Paleozoic reservoirs (i.e. "escape oil theory"), although there are others who favor the theory that oil was generated in Lower Cretaceous shales and has migrated into porous sands of the same geological age (i.e. "oil in situ").

The origin of the Lower Cretaceous oil may still be doubtful, but it is known for sure that most of the oil discoveries in coral reefs of Upper Devonian age are associated with the occurrence of oil and gas in Lower Cretaceous stratigraphic traps overlying or in the immediate vicinity of these reef structures.

The fact is perhaps best illustrated in the general Edmonton area, and the area east and southeast of Edmonton towards Princess.

In the areas of biohermal reef development of the D3 (Leduc member of Woodbend formation), the D2 (Nisku) and DI (Wabamun) biostromes (blanket type reefs) are draped over the underlying biohermal reef structure due to differential compaction so that one finds pronounced structure in the Devonion D2 with a certain amount of closure. The Mississippian pinchout is just west of the main biohermal reef trend with the result that Lower Cretaceous beds rest directly upon the eroded surface of the D1 (Leduc field) or sometimes of the D2 (Redwater field).

Although the Lower Cretaceous beds unconformably overlie the erosional surface of the Devonian, large structural features such as Devonian reefs as a rule are reflected as less pronounced features in the overlying strata. Thus, Lower Cretaceous structures with relatively small closures are in most cases found overlying biohermal reef structures (Leduc, Golden Spike, Stettler, Acheson, Morinville, etc.)

These Lower Cretaceous structures may form suitable reservoirs for the accumulation of oil and gas provided that porous sands are present.

Generally, it is found that sands are best developed on the flanks of these structures, while on the high crest they tend to shale out or change facies into fine silts, and thus form stratigraphic traps over and along the flanks of these Devonian reef structures.

Usually these stratigraphic traps overlying and in the immediate vicinity of Devonian coral reef reservoirs in the general Edmonton area contain high gravity oil associated with gas. The oil has often been found to be identical in its characteristics to Devonian oil in the underlying strata indicating the oil to be of Devonian origin (i.e. "escape oil").

Even if this were not the case, and oil was formed "in situ," and migrated laterally into porous sands structurally updip, it would be reasonable to expect that these accumulations would occur in the Lower Cretaceous structures, which have been formed by draping over Devonian reefs.

The occurrence of heavy black oil or tar in areas northeast and east of Edmonton, viz Athabasca Tar Sands, Vermilion, Wainwright and Lloydminster fields, strongly point to "escape oil," as

The Author

P. Klaui is a senior member of the firm of Trafford and Associates, a consulting group of Calgary, Alberta, Canada. A geologist, Klaui joined the Shell Group in 1927, serving in Holland and later in the Dutch East Indies as a field geologist. Between 1937 and 1942 he served in the geological and geophysical departments of Standard Oil of California in the East Indies. During the war he joined the Royal Netherlands Navy and subsequently was taken prisoner by the Japanese.

Klaui went to Canada in 1948 as senior geologist for Standard California, moving to Bay Petroleum in 1949 where he was division geologist until joining Trafford and Associates in 1951.

†Article was submitted for publication prior to the recent Stanolind Imperial St. Albert No. 1 wildcat discovery. The well was a Devonian D2 high gravity oil producer. (See Letters to the Editor.)

EXCLUSIVE

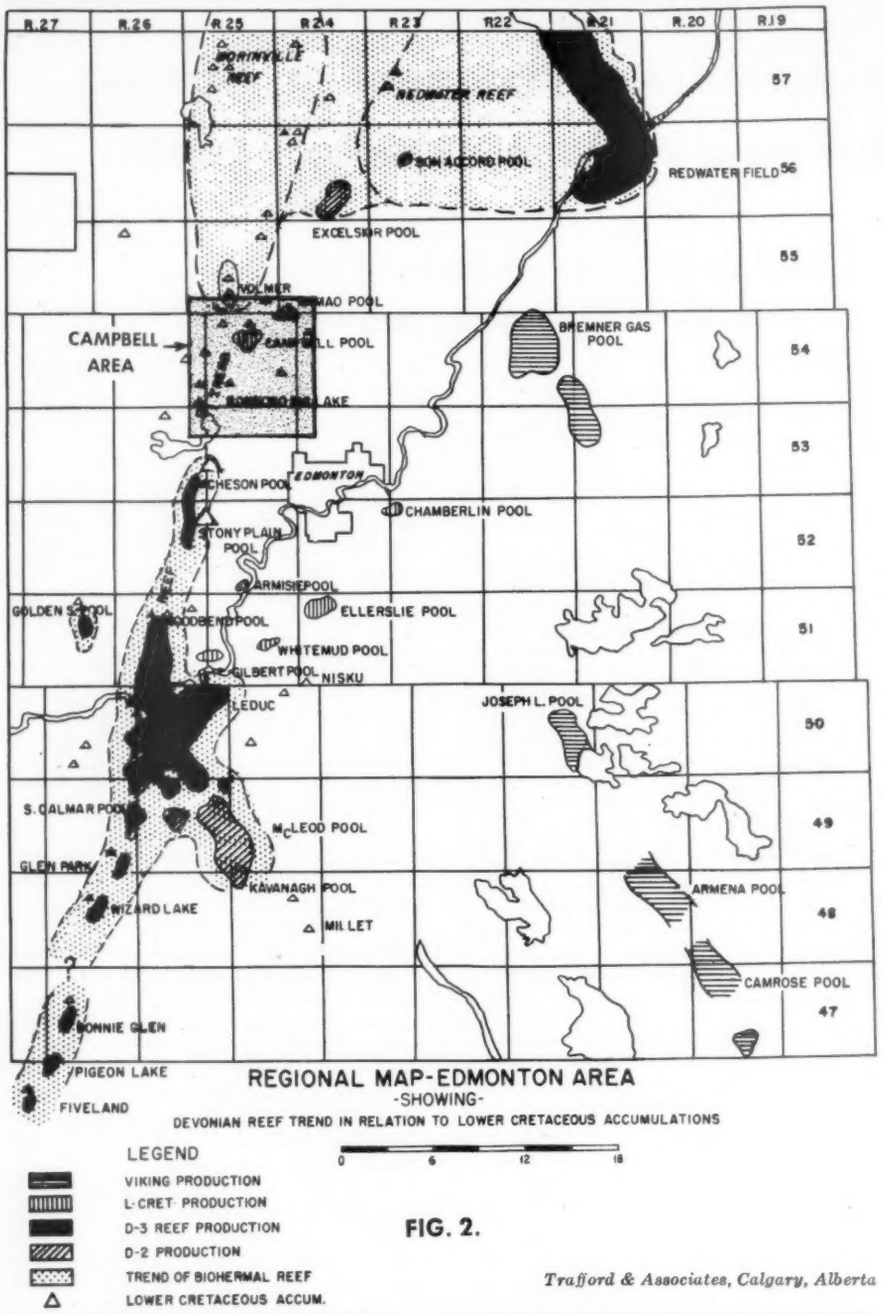


FIG. 2.

Trafford & Associates, Calgary, Alberta

in these areas the Lower Cretaceous sands rest directly upon the eroded D3 equivalent, which is pinching out eastwards up the regional dip (see Fig. 1 on which the Lower Cretaceous formations are assumed to have been removed).

In other parts of the province, Lower Cretaceous oil may have been formed "in situ" as for instance in Southern Alberta, and the Foothills structures. One should bear in mind, however, that here again Paleozoic structures and Paleozoic reservoirs (in this case the Mississippian Limestone reservoirs) appear to be related closely to Lower Cretaceous accumulations.

In connection with this it is perhaps worthwhile to mention the Cutbank oilfield in North Montana across the U. S. border. The Cutbank field is an outstanding example of a typical Lower Cretaceous stratigraphic trap. It has yielded some 100,000,000 bbl of high gravity oil (36-40 deg API) from the Cutbank sand, which is unconformably laid down against the west flank of the Kevin Sunburst dome, a structural high part on a broad regional feaure known as the Sweetgrass Arch uplift.

Another example is the Turner Valley oilfield where Lower Cretaceous sands ("Dalhousie" and "Home" sands) were found to produce high gravity oil directly associated with Mississippian productive limestone, which is known to be a biostrome type of reef.

The heavy black oil of Taber in Southern Alberta, does not, however, fit into the picture although here oil still may be of other than Lower Cretaceous origin. Some geologists believe that the Lower Cretaceous accumulations in southern Alberta are related to the underlying Jurassic beds and could possibly be of Jurassic origin.

It is outside the scope of this article to describe the geological conditions or dwell further on the possible source of Lower Cretaceous oil and/or gas for all individual cases.

It might be of interest to review briefly the history of one particular pool and as an example the Campbell pool is perhaps representative.

Campbell Pool

This field, which lies about 8 miles northwest of Edmonton, forms part of the general Campbell area itself lying in what to geologists is an extremely interesting gap of ten miles between the Acheson reef to the south and the Morinville reef to the north (see map). Fig. 2.

In this area a number of tests have been drilled on seismic anomalies believed to be indicative of Devonian D3 bioherms. All failed to find the true D3 reef, although some evidence of reef build-up has been found in the Duvernay, which still encourages the expectation that D3 bioherms will be found in the general area.

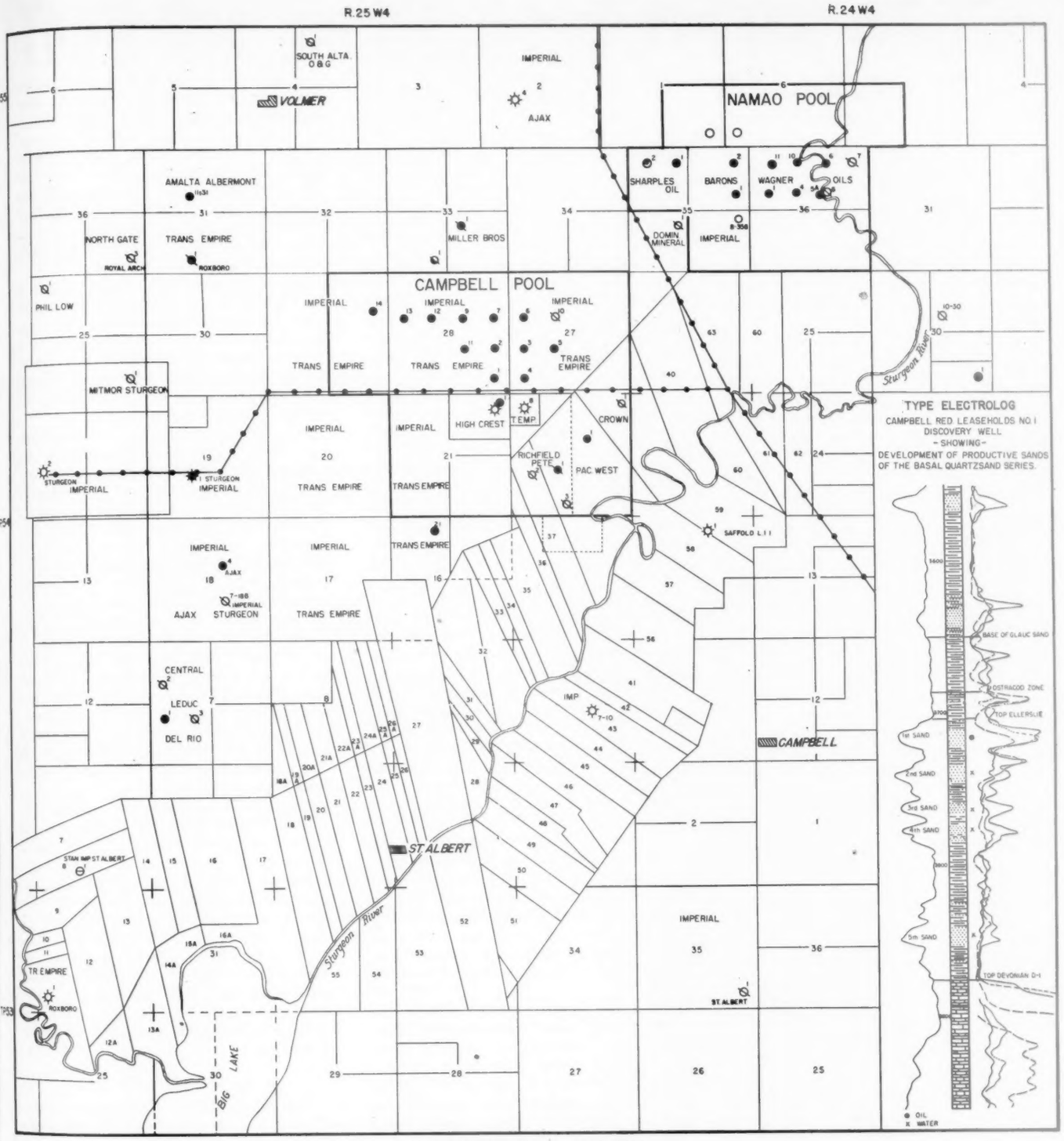
It is noteworthy and may be significant of a possible Devonian source that the wells in the Campbell pool and surrounding wildcats have almost without exception found high gravity oil or gas in the Basal Quartz sands of Lower Cretaceous age and that not only in the Campbell pool itself but in some isolated wells in the area production has been commercial. Quite apart from their own value, these indications make the area attractive for further Devonian exploration.

History and Development. The discovery, Redwater Leaseholds Campbell No. 1, was spudded in Lsd 1-28-54-25 W4th on April 27, 1949. The location was chosen on a seismic anomaly and was drilled to a total depth of 5009 ft in the Green Shale (Ireton) of Upper Devonian age. No trace of Leduc (D3) bioherm was found. Both the Wabamun (D1) and Nisku (D2) biostromes were tested, but were found to be non-productive. It was plugged back to a Lower Cretaceous horizon that was found to be productive on a drillstem test and completed for an initial production of 16 bbl per day of 33 deg API gravity oil on the pump with a rather high gas oil ratio.

Since the discovery well, 21 more wells have been drilled. As to date 14 wells are capable of producing oil of which 12 wells are reported to be on steady production and 2 wells are being reworked. The remaining 7 wells have been abandoned.

To the northeast, in the so called Namao pool in Section 36 and 35, Twp. 54, Range 25, W4th, 12 more wells were drilled. Nine of these wells found the Lower Cretaceous to be productive and 3 were abandoned.

Production in the Namao Pool is obtained from one thick sand instead of the four thin sands as in the Campbell field. The Campbell and Namao pools are considered to be seperate reservoirs.



LEGEND

- LOCATION
- DRILLING WELL
- GAS WELL
- GAS WELL WITH OIL SHOW
- OIL WELL
- ABANDONED OIL WELL
- ABANDONED WITH OIL SHOW
- DRY HOLE
- GAS LINE

CAMPBELL AREA

MAP SHOWING CAMPBELL AND NAMAO POOLS
IN RELATION TO SURROUNDING WILDCAT WELLS

1 MILE

FIG. 3.

Trafford & Associates, Calgary, Alberta

To the west and southwest 12 wildcat wells were drilled. Five found production while the remaining 7 wells were abandoned.

Present daily allowable from the Campbell pool is about 180 bbl per day for a cumulative production of ±155,000 bbl to August 31, 1952.

Geology.

Structure. The main feature of the field is a "structural low" enclosed by two "structural highs". The structural low has a northeast-southwest trend at almost right angles to the regional strike.

Structure is probably due to deposition and compaction of the Lower Cretaceous Basal Quartz sand series over an erosional high in the Wabamun (D1). This theory is supported by the seismic picture that places the Campbell pool on the north and northwest flank of such a Devonian high.

The seismic reflections are believed to be from a reflecting horizon at or near the top of the Devonian. Therefore, the seismic picture may represent a combination of both Lower Cretaceous and Devonian reflections and may indicate paleotopography rather than reef structure.

Subsequent to the deposition of the Basal Quartz sands, which unconformably overlie the erosional Devonian surface, regional downwarping would account for the pronounced southwest regional dip and may explain the change of facies and the lenticular nature of the porous sands that were laid over

and against these erosional highs in a shallow sea.

The lenticular nature of porous sands interfingering with silts and silty shales has resulted in the forming of stratigraphic traps, some of which are found to be oil and/or gas bearing and others water bearing.

Oil and gas accumulations are controlled by both structural and stratigraphic conditions with structurally high wells often non-productive as a result of lack of porosity and permeability.

Regional downwarping may account for migration of gas and oil to the structurally higher parts of the traps with water accumulation in the structural lower parts.

Stratigraphy. The productive sands belong to the Ellerslie member of the Blairmore formation and are of Lower Cretaceous age. The beds as a whole are brackish water to shallow marine in origin as indicated by their fossilliferous contents.

Four distinctive sand units can be recognized, which vary widely in thickness. These lenticular sand units are separated by impermeable streaks or lenses of shale or siltstone, which divide the pool into four separate reservoirs.

Porosity and permeability vary widely throughout the field and as a rule the productive sands are better developed on the flanks of the highs, and in the structural "lows," than on the crest of the "highs" where they tend to shale out.

When well developed these productive sands are clean, fine to medium grained, angular to subangular quartz sands, firm or friable, interbedded with sandy shales, silts, or shale streaks. Sometimes they are slightly crossbedded.

In some wells a fifth basal sand was found, but it appears to be non-continuous and no commercial production has yet been found in it.

The Basal Quartz sands are immediately overlain by a dark grey to dark brown grey impervious shale with an average thickness of 40 ft, which forms a good caprock. This shale is called the Ostracod shale and contains an abundance of ostracods, pelecypods, gastropods, and fish remains near the base in the general Edmonton area. It makes an outstanding marker, both in cores, samples and on the electrolog where it shows a very pronounced resistivity "kick" and a low, self potential curve.

Overlying the Ostracod shale are the Glauconitic sands, which can be easily recognized in samples and by their electrolog characteristics. Often these glauconitic sands have brown oil staining and contain some gas.

At the base of the quartz sands is a widespread major unconformity between the Mesozoic and the Paleozoic so that these sands unconformably rest upon the Wabamun (D1), a biostromal type of reef of Upper Devonian age.

The Paleozoic (Wabamun) surface is very irregular on account of erosion and there is some evidence of "Karst topography" in the adjacent areas. In the general Edmonton area the Wabamun shows dark brown oil staining and contains some gas. In some parts of the Leduc-Woodbend field, and in the Armena area, the Wabamun has been found to contain medium to high gravity oil in commercial quantities.

In some of the wells that penetrated the uppermost part of the Wabamun, the limestone contact is not clearly recognized. A strongly calcareous sandstone or sandy limestone is present, which most probably consists of reworked material and marks the unconformity. This zone has been called the "Detrital Zone".

As this discussion is restricted to the Lower Cretaceous productive sands no attempt has been made to describe the stratigraphy of the Devonian section that was penetrated in the Redwater Leaseholds Campbell No. 1 discovery well.

The irregular interbedding of sandstone with shales and siltstones, as present in the Campbell area, is characteristic of the Basal Quartz sand series and indicates a transgression and regression of a shallow Lower Cretaceous sea with estuaries, deltas, embayments, sandy beaches, etc. Thus the true shape and extent of productive sands of a reservoir like the Campbell pool is difficult to predict.

The limits of production of the Campbell pool have not yet in fact been delineated by drilling. As mentioned earlier, however, most wildcats in the general area have given encouraging results so that overall prospects are considered excellent for the development of a substantial producing area from the Lower Cretaceous with the added attraction, in the writer's opinion, that the area is favorably located from a regional point of view for Devonian accumulations.

Production Problems. In citing the Campbell pool as an example of a Lower Cretaceous accumulation from a geological point of view it must also be pointed out that production-wise it has had its share of problems and that, again, these problems are fairly representative of those encountered in other pools.

Since the completion of the first well in June 1949 many practical difficulties have been experienced. Among them high gas-oil ratios have been particularly burdensome to operators in that production penalties are applied for gas oil ratios over 1000. Another difficulty has been the inability to exclude water while one of the most irksome and all too frequent occurrences has been the failure of wells on production test to reproduce the encouraging indications obtained on drillstem tests.

In the fall of 1951 difficulties due principally to high gas oil ratios were such that the Campbell pool was virtually shut in. At this stage considerable testing and research was carried out and as a result the difficulties were largely overcome and the field has been on steady production since.

It is not the intention to discuss these difficulties (and their solution) in detail, but it may be valuable to mention some of them in general terms as they have undoubtedly caused a detraction from the attractiveness of Lower Cretaceous "plays". Considering the widespread possibilities of this horizon the detraction is unfortunate.

A point that led to many difficulties was lack of familiarity with sand completions in general. This was probably because earlier local experience was largely of Turner Valley and Madison limestone production, while after the discovery of Leduc, Devonian reef was in the forefront of everyone's mind. Both offer simpler production problems than those encountered in the rather thin, low relief Cretaceous sands.

The Cretaceous sands are particularly susceptible to water blocking from poor mud. Hence good rises were often experienced on drillstem tests, but after completion these results were not reproduced in spite of mud acid, extensive jet perforating, etc. The answer is, of course, low water-loss mud.

Another major problem was the effective isolation of the oil pay from the gas above and the water beneath, not only as between the separate sand lenses but often as within each individual sand. Part of this problem was purely mechanical and its solution could be reached by better cement jobs, use of centralizers and scratchers, and by subsequent employment of block squeezes. Fundamentally the same problem, but related to the physical characteristics of the reservoirs, was the segregation of the oil during production. In these flat, thin sands the gas/oil interfaces and oil/water interfaces are relatively close. Therefore, a high draw-down tends to "cone in" gas or water. Such conditions arose on drillstem tests, swabbing tests and also when producing at too high a rate. Many of the high gas oil ratios were found to be due to this cause and once started, due to the gas's preferential flow characteristics compared to oil, the condition became aggravated. Only long shut in periods succeeded in restoring the equilibrium of the gas/oil contact. Drillstem tests can be avoided (at least in development work) by reliance on electrolog and core data, swabbing can be dispensed with, and once on production, rates can be kept in line with reasonable pressure drawdown.

Conclusions

The Basal Lower Cretaceous sands, which are widespread in Western Canada, have given countless shows of oil and/or gas, some marginal production and some commercial production. Due to the irregular nature of their deposition, accumulations are often spotty and continuous reservoirs are likely to be limited. Again, the sands so far seem to be relatively thin. Gas, oil, and water are closely related within the sands so that completion may be relatively difficult, and offtake must be restricted to modest rates. It is unlikely that these sands will rival the spectacular limestone/dolomite reefal fields. Nevertheless, due to their widespread nature they represent a very large potential reserve of oil, and gas and one that undoubtedly will be developed profitably as markets become available. * * *

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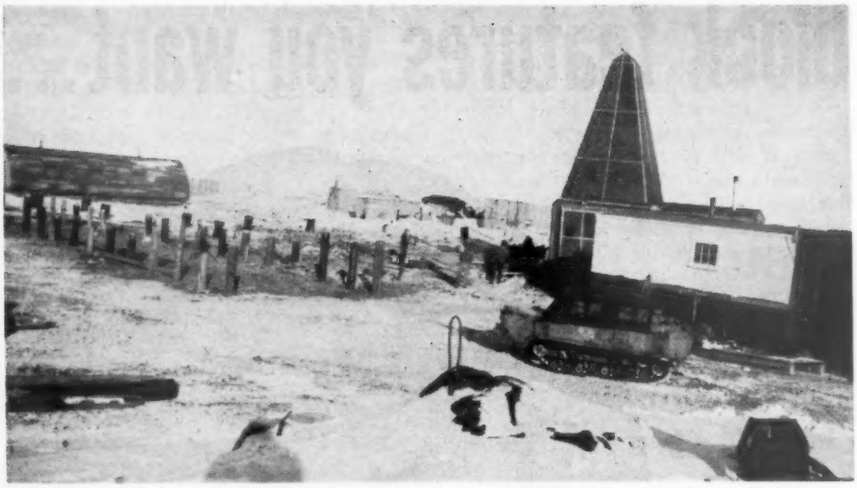


Piling steamed in for deep well foundation.

Operating Problems in Oil Exploration in the Arctic

Drilling in Arctic slope of Alaska presents relatively new problems in transportation facilities, casing collapse, etc.

KARL L. VONDER AHE*

SINCE the Navy started drilling prospect wells in Naval Petroleum Reserve No. 4 on the Arctic slope of Alaska, many problems have been encountered that are relatively new to the oil industry. These problems were primarily caused by the presence of the permafrost layer of frozen ground extending from two feet below the surface to as great a depth as 1150 ft in which the constant temperatures range from 32 F at the base to as low as 14 F at approximately 100 ft. Above 100 ft the temperatures vary seasonably from much lower to considerably higher, with the two feet below the surface being the only part that thaws annually. Fig. 1, which is a composite of temperature findings through the permafrost in a number of locations, illustrates the approximate average conditions encountered. It is worthy of note that the thermal gradient with depth approximates that found in wells in the temperate zone. But it starts 50-60 F lower on the scale.

Problems posed by these conditions are:

1. Transportation difficulties during the summer and fall months when the surface of the ground is thawed.
2. Thawing of foundation footings due to heat transfer from the drilling mud circulated in deep wells.
3. Retardation of setting time and refusal of cement to set around casing within the permafrost.
4. Collapse of casing caused by expansion of ice upon freezing of mud or water in the annulus.
5. Blocking of oil production by ice in shallow oil sands.
6. Formation of hydrates in casing and tubing of high pressure gas wells shutting off the flow of gas.

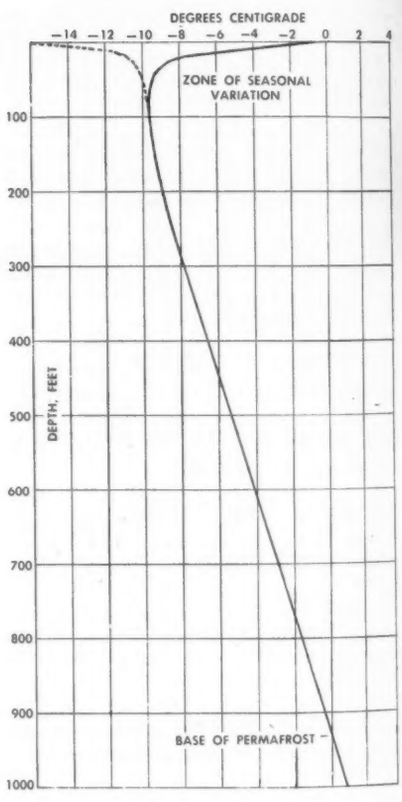
Transportation Difficulties

Perhaps the foremost hindrance to the Navy's exploration program is the problem of transportation. As there are no transportation facilities into the Reserve from the interior of Alaska other than by air it is much more economical to ship the bulk of the heavy equipment and non-perishable supplies by water to Point Barrow, the base of field operations. Because the Arctic Ocean is free from ice along the coast for only a short period of time in average years, it is necessary to plan months ahead to have all the material purchased and at the port in time to complete loading operations early in July.

After the material is unloaded on the beach at Point Barrow there is still the problem of transportation to the rig sites, which range as far distant as 175 miles airline. Because the Arctic Slope is a network of lakes, swamps, and rivers with the higher ground only a spongy tundra, the only time it is feasible to haul heavy loads is late in winter after the swamps, lakes, and streams have frozen to a depth sufficiently great to support the tractors and loads. Forty inches of sea ice is necessary for hauling along the coast.

The building of the camp, rig foundation and derrick follows as soon as possible thereafter. This usually means May or June before the well can be spudded in and drilling then continues through the summer and into or through the winter months if necessary. A rig and camp, however, must then be ready to move in time to reach the new location by about the first of May if it is to be used and same season on a new well or softening of the surface will prevent transportation.

In order to have, for example, the materials on hand for use in 1952 and through to the completion of a project (that may extend to possibly as late as the spring of 1953) the requirements have to be planned and the orders issued by January of 1951 for the material to be loaded aboard ship and delivered in August at Point Barrow. From this it will be seen that the planning

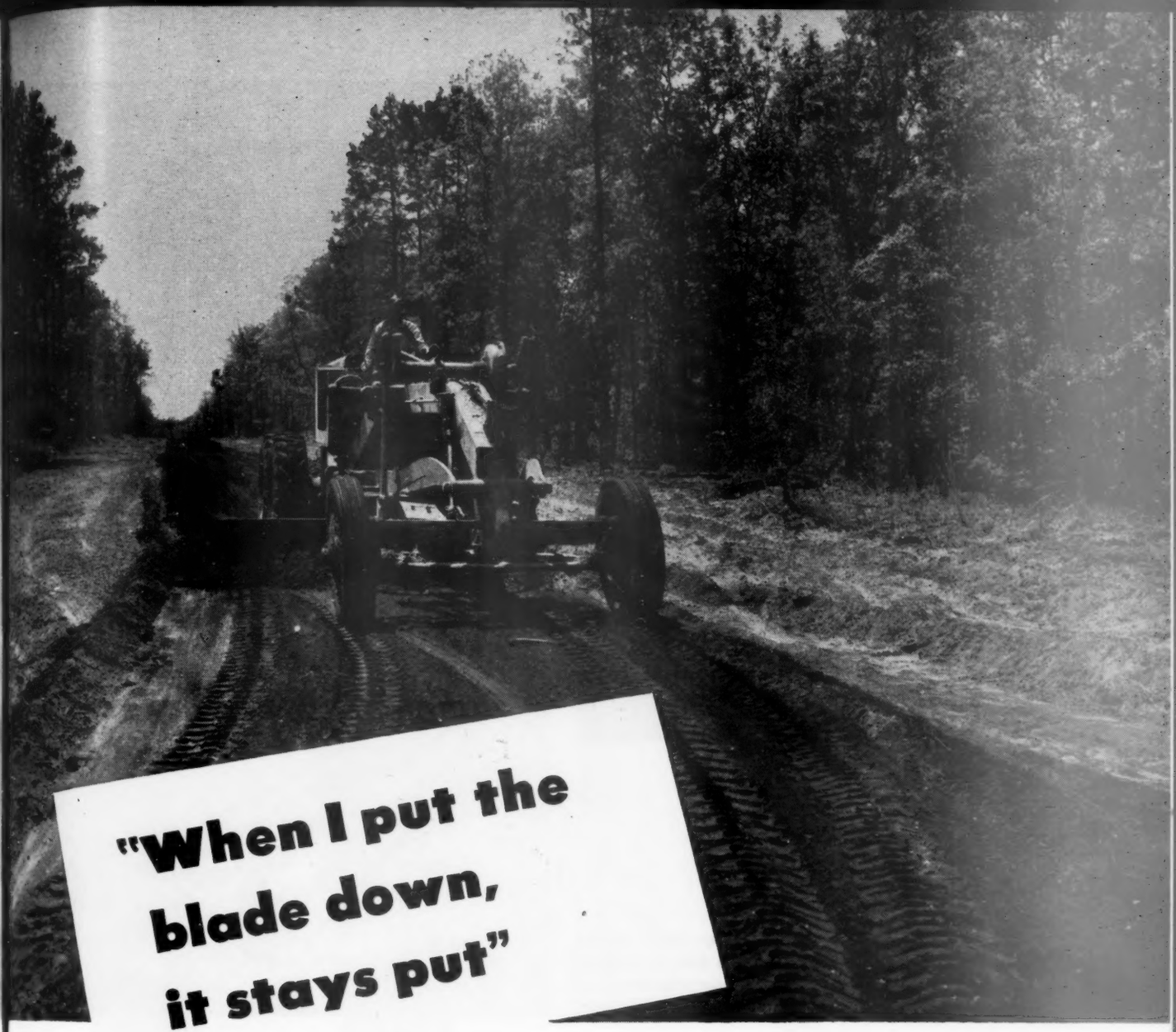


COMPOSITE THERMAL GRADIENT IN PERMAFROST
Seasonal variation above 2'
From —18° to —½° at 2'
From —22½° to 5° at 1'
From —25° to +13½° at surface.

FIG. 1. From permafrost studies by Dr. G. S. MacCarthy, USGS.

*Chief petroleum engineer, Naval Petroleum Reserve No. 4 Arctic Contractors — Contract NOY-71333.

EXCLUSIVE



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Above, ice dike in cellar wall of test well.

Above, right, poor foundation condition—ice lens below tundra.

Right, truss for cellar support of casing in a deep well. Fitted so refrigerant was circulated through it when in place.

has to be done at least two years in advance of completion of the work.

The fact that most of the ground surface is frozen muddy water covered with a thin layer of moss hampers transportation by air also because airstrips for the heavier planes can be built only on ocean beaches, gravel beds in the larger rivers, or on the higher ridges where the more competent formations are outcropping. The latter may soften in summer making them unusable for a few months. The larger lakes serve as air strips during the few months when ice of sufficient thickness is present and permits the landing of even the larger planes such as a DC-4 with full loads. Transportation of personnel, perishable foodstuffs, and supplies is nearly always possible by bush plane if weather conditions permit. During the thaw or freeze up there may be a delay of a week or so when the ice is too thin to support a plane on skis or wheels, and too much ice is present to permit operation of planes on floats.

During much of the period in which it is impossible or impractical to haul by cat train, it has been found practical though not economical to haul supplies by LVT, the amphibious carrier developed during World War II. These carriers are capable of transporting up to 12,000 lb each, but on long hauls the pay load is cut down to allow for extra fuel and spare parts. The only other vehicle that can be operated successfully throughout the year and in all parts of the Reserve is the weasel, the small amphibious carrier used mainly for personnel, and this used extensively. In fact it is indispensable.

Thawing of Rig Foundation Footings

On the Arctic Plain, north of the foothills and in many places within the foothills, the surface formations contain lenses and dikes of ice that vary in extent and thickness. Even when these are not present the top 30 to 50 ft of the formation has such a high water content that when thawed the remaining material has no structural strength as a supporting medium. Although the permafrost does not ordinarily thaw for a depth greater than 2 ft during the summer, a rig drilling for a number of months and circulating considerable volumes of hot mud from depth will disperse enough heat laterally into the formations under the rig to endanger the foundations in spite of the fact that foundation piling are set to a depth of 20 ft below the surface. Similarly, the cement around any casing in this kind of formation ceases to be a seal when the ice melts around it. For these reasons the conductor pipe is set at a depth of about 100 ft or more with the top 60 ft jacketed with a larger sized pipe that leaves a dead air space 2 or 3 in. thick in the annulus to act as an insulator. It has been demonstrated that this permits drilling through the permafrost and setting the surface casing below it without circulation breaking out around the conductor pipe before the operation is completed.

As a safeguard against thawing at later stages around piling under foundations refrigeration has been resorted to. In one deep hole drilled to nearly 12,000 ft the use of metal pilings and circulating a refrigerant through them, and also through the jacketed annulus of the surface casing has proved satisfactory. Another well drilled almost as deep used only dead air space in the jacketed casing and a mat instead of

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Load of fuel oil — cat train on ocean ice.

"Plow" or "lead" caterpillar on cat train on ocean ice.

piling, the refrigerating pipes were below the mat. Shallower wells, to about 4000 ft to 5000 ft in depth can be drilled before sufficient heat is lost to the formations near the surface become a menace.

In planning a well to be drilled to more than about 7000 ft the sustaining of the frozen condition of the surface formations below the rig foundation becomes of paramount importance.

If the top of the first competent formation is not too deep, piling can be set far enough into it to be satisfactory.[1] With the ground frozen as it is, however, piling cannot be driven into it but must be set in holes of proper depth. In the winter time these holes can be made with steam points but this transmits considerable heat to the formations around the holes and if ice is present in the form of dikes or in layers it will thaw back for some distance and cause trouble until the formations have cooled down and the water has re-frozen. This method cannot be used in late spring or summer because the water will not freeze again. To set the piling deep or set it late in the spring the holes must be drilled.

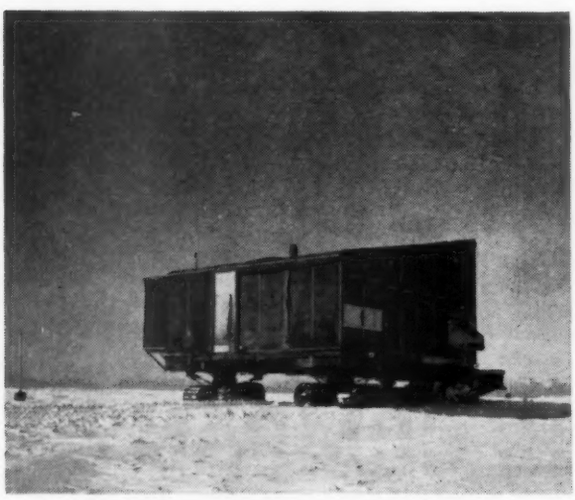
In some places the top of the competent formation is as deep as sixty feet below the surface. It is impractical to set piling into this, particularly when the piling above that depth would be unsupported laterally if the upper formations are thawed out by the heat transmitted from the mud circulating in the casing. Refrigeration then would still be necessary.

One foundation that has proved satisfactory under such conditions is a simple mat of timbers with refrigerating pipes attached along the bottom of each timber. Refrigeration through these pipes helps to freeze the foundation back at an earlier date and keeps it frozen during the summer months. It also assists in removing the rig and substructure when drilling is completed by reversing the process and using the refrigerating pipes as steam pipes to thaw the formations below the timbers and so free them for easy removal. The only piling required for this plan is for beneath the corners of the rotary table.

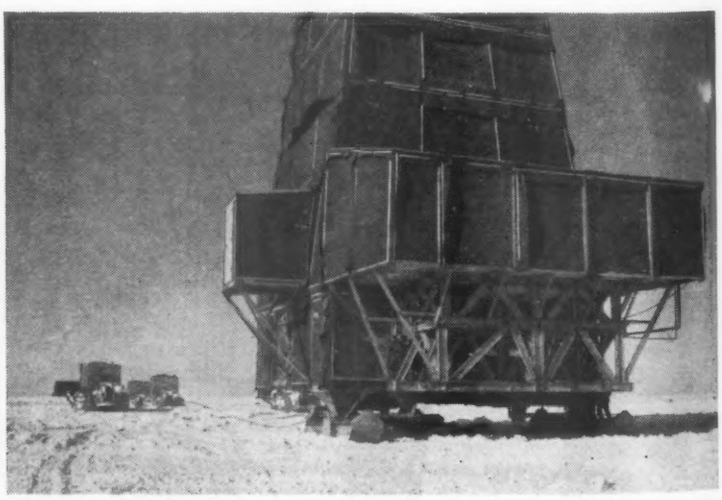
Cement, Retardation, and Failure to Set

Although concrete in surface installations can be quite easily forced to set in sub-zero weather by covering it with slightly raised tarpaulins and then cause hot air to circulate in this space for a period of two or three days, neat cement slurries used to cement casing in the permafrost at temperatures between 14 F and 32 F have often failed to set. Even at depths of a couple of hundred feet below the base of the permafrost the temperature of 34 to 36 F slows up the setting of cement seriously unless an excessive amount of accelerant is used and the cement slurry is mixed at as high a temperature as is considered safe. At sub-zero surface temperatures it is necessary to cover the dry cement and

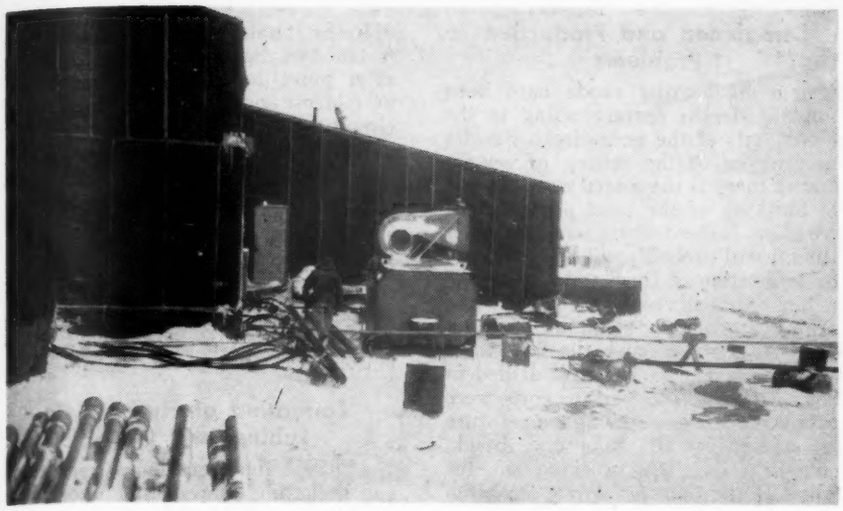
[1]Soil Mechanics and Foundations by Plummer and Dore.



Pump house for Cardwell rig, mounted on Athey tracks towed by one D-8 caterpillar tractor.

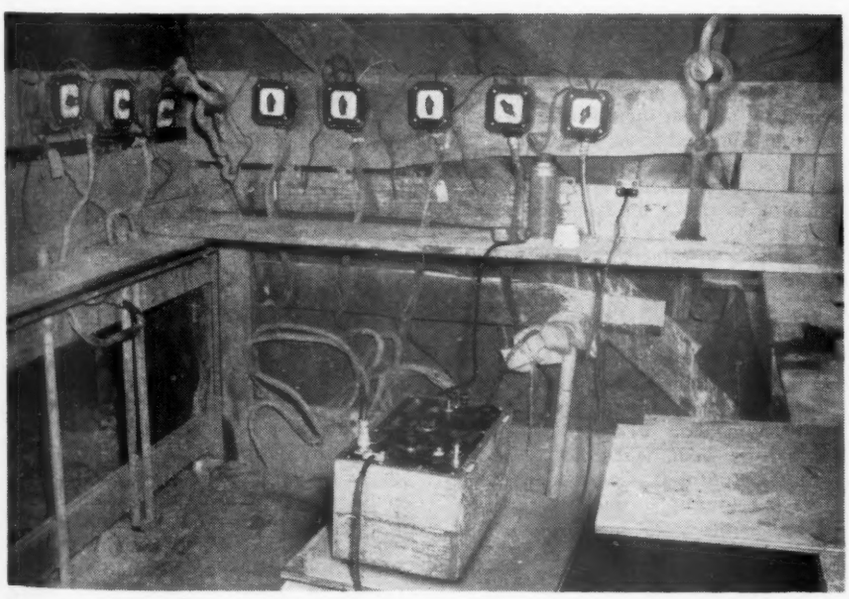


Unitized Cardwell rig with 87-ft derrick mounted on sled runners.



Refrigerator and header intakes and returns to foundation piling and cellar truss.

Using cement stored in ammunition cans.



Thermocouple selective switches and potentiometer for periodic check of sub-surface foundation temperatures.

apply heat for 24 to 48 hours or longer, prior to the start of the cementing job in order to bring the temperature of the cement up to 20 deg above zero or higher. Then with the mixing water at 100 F to 120 F the slurry can be pumped into the well at about 70 F or higher. With these precautions and using 4 per cent calcium chloride in the mixing water good results have been obtained.

Because of the difficulties encountered under low temperatures, Arctic Contractors and the Navy have carried on some research along this line. Major F. L. White, USAF assigned to the Navy, experimented with various types of cement, with and without additives, mixing the slurries at about 70 F and allowing them to set at temperatures as low as 14 F. Some good results were obtained with the stronger concentrations of calcium chloride and also with 10 per cent sodium chloride in the mixing water at temperatures near freezing but for lower temperatures the best results were obtained with gypsum cement. Gypsum cement does not have the strength of construction cement or oil well cement nor is it as stable as it is slightly soluble in water. It does have ample strength, however, to be used for cementing the conductor pipe and it has the advantage of being able to take an initial set at the low temperatures in the permafrost before the cement freezes.

After cementing the conductor pipe at about 90 ft it is the practice to run drill pipe to the top plug and to circulate heated mud for about 12 hours to accelerate the final set and hardening of the cement. (Gypsum cement does not require the addition of extra heat in order for it to take an early initial set). As the lower 30 ft or more of the pipe is in a competent formation that is unaffected by this applied heat, or the heat of hydration of the cement, the upper portion of the walls of the hole, if much ice is present, will thaw away from the cement. After the cement has set, and it is allowed to set undisturbed for a day or so, the formations will freeze back to the cement, but will thaw again as drilling continues. It is for this reason that the top 60 ft of pipe are jacketed with a larger pipe. The insulation given by the dead air space helps to reduce the transference of heat from the circulated mud to the formations at the surface and by so doing gives added insurance of the competence of the rig foundation.

Possibly the development and use of a special, low temperature cement might be in order. Because of the limited use of such a product, it would probably be more economical to determine the most satisfactory additive for standard cements in order to obtain the desired results.

Collapse of Casing

There is definite proof of casing collapse at shallow depth within the permafrost in at least one well, and evidence of collapse of surface pipe in several others. This is attributed to freezing of the drilling mud in the annular space between the casing and formation.

With a good cement job around the

shoe of the surface casing the annulus is thus sealed off at the lower end and the formation of ice in the upper part of the annulus gradually freezing downward creates terrific pressures capable of collapsing the casing. The coldest point in the permafrost in summer is about 14 F at a depth of about 100 ft, and as low as minus 20 F or so near the surface in winter. The ice naturally forms first at the coldest point and gradually freezes downward and its expansion upon freezing causes the pressure below to increase in proportion. This pressure is transmitted all the way down to the top of the cement by the unfrozen mud column and the pipe will give way at its weakest point. If all the water in the sands within the permafrost is frozen these formations become completely impervious and there can be no release of this pressure.

When water is frozen in a confined space the maximum pressure obtainable through expansion cannot exceed 30,074 psi at –22 C (7.6 F). At this temperature and pressure, ice, which is denser than water, begins to form. With the increase in pressure above atmospheric the freezing point is lowered so that at 14 F (–10 C) the pressure might build up to about 13,000 psi. This pressure is greater than the collapsing strength of most casings commonly used. There is little danger even if the casing is collapsed as long as the ice remains, but if production is obtained at depth the warm fluid passing upward will eventually thaw the ice and any break in the casing is then exposed and allows the well pressure access to the annulus. In this way the oil field as well as the well itself could easily be damaged.

To overcome such possibility it is necessary to prevent the formation of ice either by (1) replacing the fluid with a solid such as cement; (2) to lower the freezing point of the mud in the annulus with brine so that ice will not form. The freezing point of the mud can be lowered sufficiently for a limited period of time by adding common salt at the required concentration, but it is doubtful whether it would hold the necessary concentration indefinitely. (3) To displace the mud in the annulus with some fluid such as oil, which will not freeze solid.

Until more detailed information upon collapse of casing due to ice expansion is available, the latter procedure will be followed in most cases. In this casing program, the conductor pipe, set at 60 to 120 ft in depth, is cemented with sufficient cement to fill the annulus from the shoe to the surface. On all deeper strings of casing, heavy Simpson crude oil (20 API) is pumped in followed by 10 to 50 bbl of brine ahead of the cement. This leaves the crude oil filling the annulus in the top or coldest section of the hole with sufficient brine to clean the walls ahead of the cement.

As a check upon the results of the above process some of the holes were plugged with cement at the shoe of the surface casing before abandoning the well and then the mud was bailed down to about 1000 ft. Plans call for inspection of such casing at later dates to determine effectiveness of the procedure.

Completion and Production Problems

Some oil bearing sands have been found at depths corresponding to the colder parts of the permafrost. Besides the problem of the setting of cement slurries there is the added one of possible blocking of the sand pores by ice formation. If the connate water is highly saline it will probably not be frozen but any infiltration of fresh water from the drilling fluid will reduce the salinity and permit ice formation at higher temperatures than was previously the case. Some cores were taken in one well drilled in 1950 with cable tools and the cores were preserved at below freezing temperature and studied by Dr. Robert F. Black, geologist, who was working on ice studies at the time for Arctic Research Laboratory. Microscopic study showed no free water in the sand but did show minute ice crystals in the sand pores along with the oil.

One well drilled with a rotary rig and water base mud in 1947 cored oil sand and the electric log indicated an appreciable thickness of it within the permafrost, but the well could not be made to produce. Since that time one well drilled with cable tools in this area within a hundred feet of this rotary hole produced an average of more than 350 bbl a day of high gravity crude oil with only a trace of water, for 49 days with no apparent decline. The length of stroke was then reduced from 46 to 36 in. and the number of strokes from 18 to 14 per minute. The well still averaged more than 185 bbl a day for full days with no apparent decline in 31 days. This well used only a small amount of brine in the bottom of the hole while drilling.

Another well in the same area was drilled with a light rotary rig using oil base mud and was completed for a sustained rate of 200 to 240 bbl a day with no cut.

One of the wells drilled on the same structure with cable tools and brine was tested with a packer on tubing set to isolate and produce the lower sand and this well when swabbed in flowed at a 500 bbl a day rate for two hours at a time, but ice formed inside the tubing and shut off the flow. When this was thawed by pouring hot brine down the tubing or knocked loose by running the swab, the well would again flow at the 500 bbl rate for about two hours before beginning to pinch off from ice formation.

In making sustained pumping tests of this wet well, the tubing was kept free of ice by running an insulated conductor fastened to the bottom of the tubing or at a point below the bottom of the permafrost and completing an electrical circuit through the tubing using the generator on an electric welder for a source of power. The resistance of the tubing generated sufficient heat when using from 150 to 200 amp to prevent the formation of ice within the tubing. This method designed by the Contractors' staff proved completely satisfactory, but another method, using a higher voltage current and local heat applied at the bottom of the pump did not.

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Kansas Oil Output Hits New Record in 1951

Kansas broke the state's record for crude oil production in 1952, with more than 114,000,000 bbl during the year. According to the State Corporation Commission this was the largest amount ever produced in the state comparing with 113,912,366 bbl reported in 1951. Dollar value was in excess of $296,000,000.

The record production was from the state's more than 29,000 wells.

Formation of Hydrates in Tubing and Casing

Although the formation of hydrates in gas gathering lines is not uncommon, the Arctic provides the unique conditions necessary to make hydrate formation in the tubing and casing of producing wells a serious problem. In wells supplying the Point Barrow camp with gas for the past three years considerable difficulty has been encountered at times with the formation of such hydrates to the extent that they have occasionally completely shut off the flow of gas from the well. The well produces from a depth of 2500 ft and at 1000 psi, 60 F. Chilling, resulting from passing through the permafrost, makes the formation of hydrates inevitable, since some water vapor is present.

This condition can undoubtedly be overcome on any wells completed in the future by installing the same type of resistance heater used to prevent ice formation in the tubing of shallow oil wells, although it has caused some loss of time on the wells drilled previously. In some cases the hydrates have been dissipated by leaving the tubing open to atmospheric pressure but in other cases it was necessary to use a hot, concentrated calcium chloride brine or even to circulate heated oil through drill rod within the tubing. If the gas were being produced from a deep zone in volumes great enough to carry some of the heat up with it or if the gas were perfectly dry, such formation of hydrates would not be a problem.

From the foregoing it will be seen that in prospecting for oil within the Arctic Circle there are numerous conditions and difficulties which have required special attention although none of the problems are insurmountable.

Acknowledgment

Acknowledgment is made to E. L. Davis, project manager, Arctic Contractors for suggestions and criticism. Also to Captain R. H. Meade, DNPR, and Commander M. H. Aubey, OICC on the project for permission to make public the information contained herein; Dr. G. S. MacCarthy for assistance and permission to use permafrost information taken from his studies made for the USGS, and to Major F. L. White, USAF for data on behavior of various cements under conditions of extreme cold contained in "Setting Cements in Below Freezing Conditions," The Petroleum Engineer, August and September, 1952.

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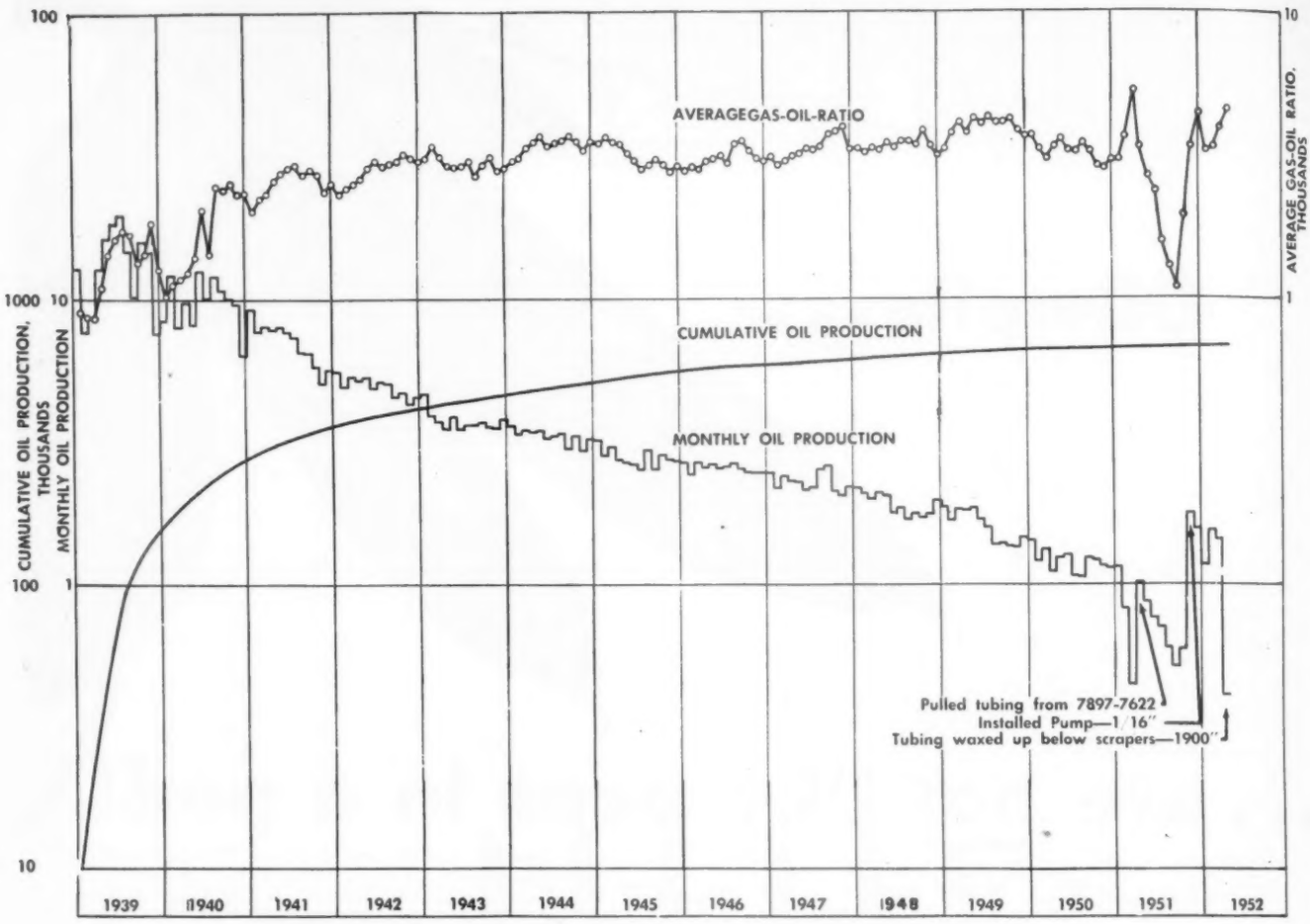

FIG. 1. Production data — Extension No. 1.

Deep Well Pumping in Canada

Wells in the Turner Valley field average 8000 ft and artificial lift poses serious problems in crooked hole, dewaxing, and corrosion

G. R. MANSON and H. G. BAGNALL

It is the purpose of this paper to discuss briefly deep well pumping in the Turner Valley field under the following general headings:

1. Installation of a beam pumping unit at Extension Royalties No. 1.
2. Problems encountered and the attempted solutions.
3. Discussion of dynamometer cards taken at Extension No. 1.
4. Recommendations for further installations.

Since crude oil was first discovered in Turner Valley in 1936, most operators have recognized that at some time in the life of the edge wells some means of artificial lift would be necessary to deplete economically the reserves. As the average depth of these wells is about 8000 ft, the solution of this problem has proved difficult.

Experiments on various type pumping methods have been conducted.

Rod Pumping

On considering rod pumping, because of the depth, the corrosive nature of the oil, and the crooked hole conditions, operators were hesitant in trying such an expensive installation. With medium depth pumping, however, experience in Central Alberta and with better alloy rods and pumps available, a rod type[1] pumping unit was installed in October of 1951, at Extension No. 1.

The well chosen by Anglo Canadian Oil Company Ltd. was one of the better wells in Turner Valley. It is situated in 1 sd. 14 sec. 17 twp. 18 R2W5 in the southern end of Turner Valley. It was completed in January, 1939, at a total depth of 8020 ft, 449 ft in the Madison Limestone. Seven inch casing was set at 7580 ft, 9 ft in the lime, and cemented with 500 sacks. Both the upper and lower porous sections were then drilled, the upper and better section extending from 7640 to 7770, and the lower from 7960 to 8010. The porous zones were acidized with a total of 24,000 gal in

†Presented at third annual meeting of the Petroleum and Natural Gas Division, CIMM, Edmonton, Alberta, May 31, 1952. Published by permission of Canadian Institute of Mining and Metallurgy.

[1]National.

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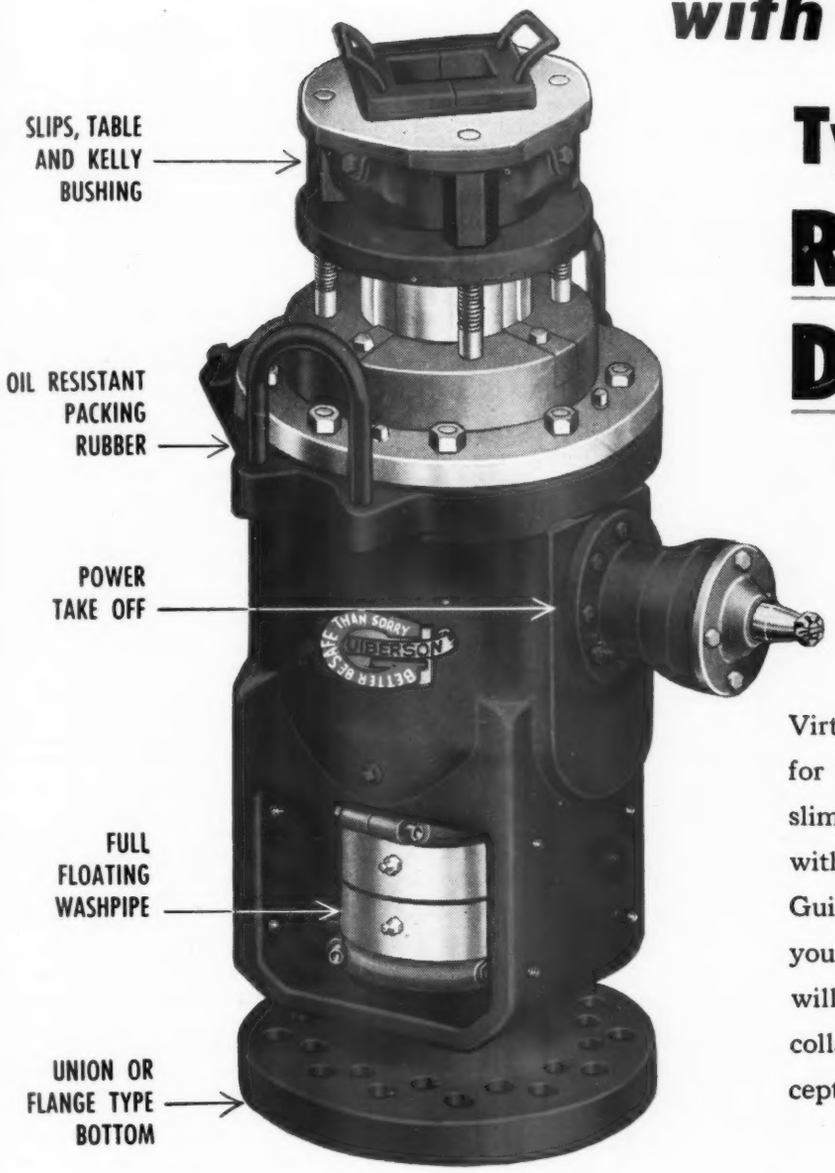

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three treatments. The initial potential on a 1-in. choke was 2256 bbl per day. Although a directional survey was not taken, assuming the deviation to be in one direction, deviation surveys[2] indicated the shoe of the 7-in. casing to be 241 ft off the vertical for an average of just under two degrees. From 3000 to 6000 ft the deviation was 2½ deg.

Until October, 1951, the well had produced a total of 603,000 bbl. A study of the production curves plotted on semi-log paper, monthly production versus time, shows a smooth flowing decline until 1947. The curve then drops off quite steeply, indicative of insufficient lifting energy. This would probably have been the time for artificial lift. Late in 1950 the well died on the tubing and was flowed on the casing until the tubing was pulled above the upper porous zone. This helped, however, only slightly and prior to pumping the production had declined to 17 bbl per day.

Design Calculations

From production history it was assumed that with proper equipment this well could produce about 50 bbl per day. As the proposed installation was purely experimental, management felt that standard resaleable equipment should be used throughout. The largest available pumping unit in common use in Alberta had a 64-in. stroke, 21,000-lb beam load and 160,000-in.-lb peak torque gear capacity.

With this jack as a starting point and assuming a setting depth of 7900 ft, calculations were made in an attempt to determine the most efficient combination of plunger, rods, and tubing, to obtain the desired production.

In order to keep the peak torque and the polished rod load to a minimum, a tapered string of rods consisting of ⅞, ¾, and ⅝ was chosen and so designed that the unit stress at the top of each section was equal.

It was assumed that a plunger diameter of 1¼-in. or 1-1/16-in. would deliver the desired production. Calculations revealed that pumping water from 7900 ft with a 64-in. stroke at 11 strokes per minute the 1 1/16-in. pump would deliver the same as the 1¼-in. pump, 64 bbl per day, and that the peak polished rod load with the 1 1/16-in. pump would be 16,850 as compared with 18,400 for the 1¼-in. plunger. The computed peak torque was 88,300 lb as compared to 121,500 lb. These results were based on the most adverse conditions as the well had shown no indication of water.

The 1 1/16-in. plunger size was chosen and the final rod string consisted of 3950 ft of ⅝, 2100 ft of ¾, and 1820 ft of ⅞. The maximum unit stress was calculated as 28,000 psi. The rods available and chosen were medium corrosion resistant and of medium tensile strength, having a yield point of 65,000-75,000, and a tensile strength of 85,000 psi.

Tubing

It was decided to change the 3-in. tubing for a tapered string of 2½ in. and 2 in. for two reasons. First, the 3-in. tubing had been in the hole for 13 years without pulling, and secondly it was felt that if the rods parted, especially near the surface, the ⅝ in. rods would have less tendency to spiral with close support of the 2-in. tubing. The final selection was 3912 ft of 2½-in. and 3987 ft of 2-in., Grade J-55, E.U.E., seamless tubing.

Subsurface Pump, Gas Anchor

For this installation a 2-in. by 1 1/16-in. by 12 ft by 16 ft RWB fluid packed insert type pump of unit barrel construction, with 6-ft plunger, double travelling and standing valves, mechanical bottom lock hold down was used. The gas anchor directly below the seating nipple consisted of a 2-in. by 3-in. perforated tubing swage, a short perforated 3-in. pup joint, a full joint of 3-in. tubing, and a bull plug. A "mosquito bill" of ¾-in. pipe, 5 ft in length, perforated in the bottom foot was attached to the seating nipple.

[2]Totco

Rod Scrapers

Wax had always been a problem in this well, and it was necessary prior to the installation of the pumping unit to dewax the well weekly. The conventional wire line method was used and in instances wax was found at depths in excess of 3000 ft. The wax was at its worst from 0-2000 ft, so it was felt that this length of scrapers would be sufficient.

A rotary scraper was chosen to distribute better the rod wear due to the possibility of dog legs in the hole. Secondly the rotary type was chosen to insure removal of the rods if heavy waxing occurred. The scrapers were finally used on the ⅞-in. rods only.

Adaptation of the Well Head

Very few alterations were made to the well head. As the casing was to be produced into the common flow line a check valve was placed just past the casing valve. As a precautionary measure in case of freezing or operator's negligence, a pop valve was used between the casing and the tubing.

Power

Here again a standard multi-cylinder engine was chosen with a view to resale. The particular engine is rated at 31 hp at 1600 rpm. It was felt at the time of the installation that if pumping were successful, electric power would be installed.

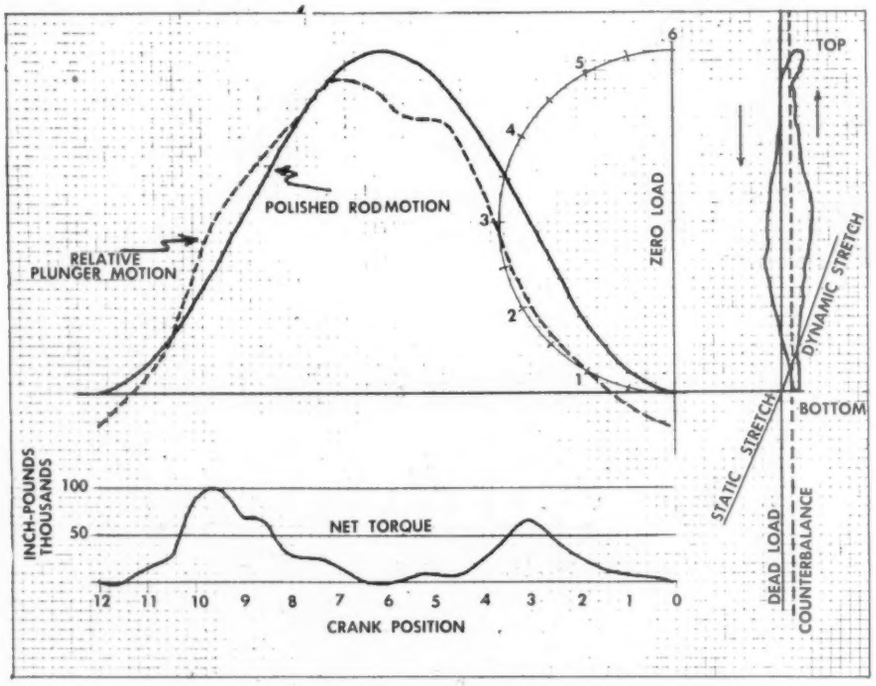
Speed of Operation

It was found from calculations that 30 strokes per minute represented a first order harmonic, 15 strokes per minute a second, and 10 strokes per minute, a third order harmonic. 11 strokes per minute was chosen as it fell within the second and third order harmonies.

Operation

The well began pumping on October 1951, and the first five months were comparatively trouble free. Some trouble, however, was experienced with the engine during this time, mainly as a result of vibration, which caused radiator trouble. Part of this vibration was due to poor setting and the lack of sensitivity of the governor. The small engine lacked the inertia to overcome the mass of the jack and load, and consequently the speed varied. With the engine speed being controlled by the throttle rather than by the governor, and with the varying load characteristics of each cycle the vibration was acute.

In the five months period after running the pump, the well produced at an average rate of 54 bbl per day. During this time the production remained constant, but there was indication of a



Extension No. 1, Turner Valley. Stroke, 64 in. SPM, 9.5. Depth, 7910 ft.

FIG. 2. Dynamometer interpretation — March 15, 1952.

slightly increasing gas oil ratio, about 3000 cu ft per barrel.

Dynamometer Cards

Dynamometer cards were taken at 9½, 11, and 13 strokes per minute.

Card at 9½ strokes per minute: (See Fig. 2.)

Max. load	14,825 lb
Min. load	9,600 lb
Av. up load	13,850 lb
Av. down load	10,920 lb
Polished rod horsepower	4.45
Peak torque	98,000 in. lb

The card here indicates very smooth plunger motion with little evidence of harmonics, which should result in long rod life. The unit at this pumping speed was slightly under counterbalanced. Correct counterbalancing would reduce the torque to about 85,000 in. lb. In the event that present production from Extension No. 1 declines, it is evident that 9½ strokes per minute would be a suitable pumping speed.

Card at 11 strokes per minute: (See Fig. 3)

Max. load	15,500 units
Min. load	9,850
Av. up load	12,300
Av. down load	9,200
Polished rod horsepower	5.42
Peak torque	96,500

It was at this pumping speed that the unit operated for the first five months. The card again indicates smooth plunger action with a small sign of harmonics. The harmonics evident are not of a serious nature, and should not effect the life of the rods to any great extent. The graphical analysis would indicate a relative plunger motion of 72 in. It must be remembered, however, that friction is reflected as relative plunger motion, and thus 72 in. do not represent the relative plunger motion in its entirety.

Card at 13 strokes per minute: (See Fig. 4)

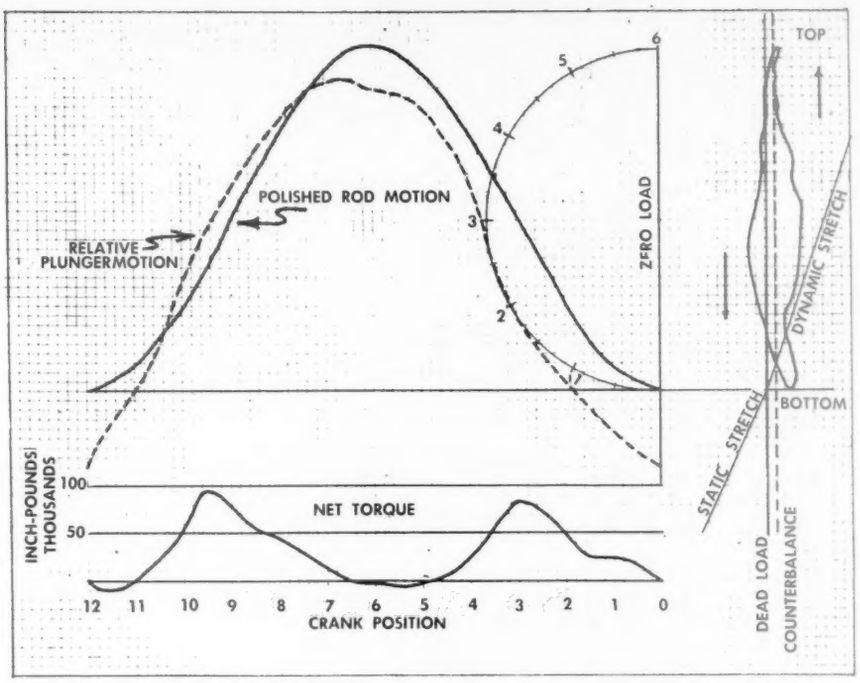
Max. load	16,100
Min. load	8,820
Av. up load	14,500
Av. down load	10,720
Polished rod horsepower	7.84
Peak torque	121,000

This card clearly displays the extra load and increased number of reversals applied to the rods by the increase in speed and the resulting harmonics. These harmonics are not too severe in this case, but may become of a serious nature if the speed were increased. Examination of the relative plunger travel and torque curve show how they are affected by harmonics.

Work Over

In April, 1952, Calgary Power was made available and the unit was placed on electric motor. The motor used was a high torque, enclosed 15 hp, 440-v type, with safety controls, heaters, etc.

By coincidence two days after the installation of the electric motor, and while readings were being taken to determine amperage and power factor, the load nearly doubled. The first reading taken was from 30-32 amps, the unit was then shut down to adjust the counterweights. Upon restarting the unit the amperage increased to 60 amps, and the safety controls broke the circuit.



Extension No. 1, Turner Valley. Stroke, 64 in. SPM, 11. Depth, 7910 ft.

FIG. 3. Dynamometer interpretation — March 15, 1952.

In order to determine the cause for the increased load, further dynamometer cards were taken and revealed again that the plunger was operating smoothly. Results were as follows:

Card at 11½ strokes per minutes: (See Fig. 5)

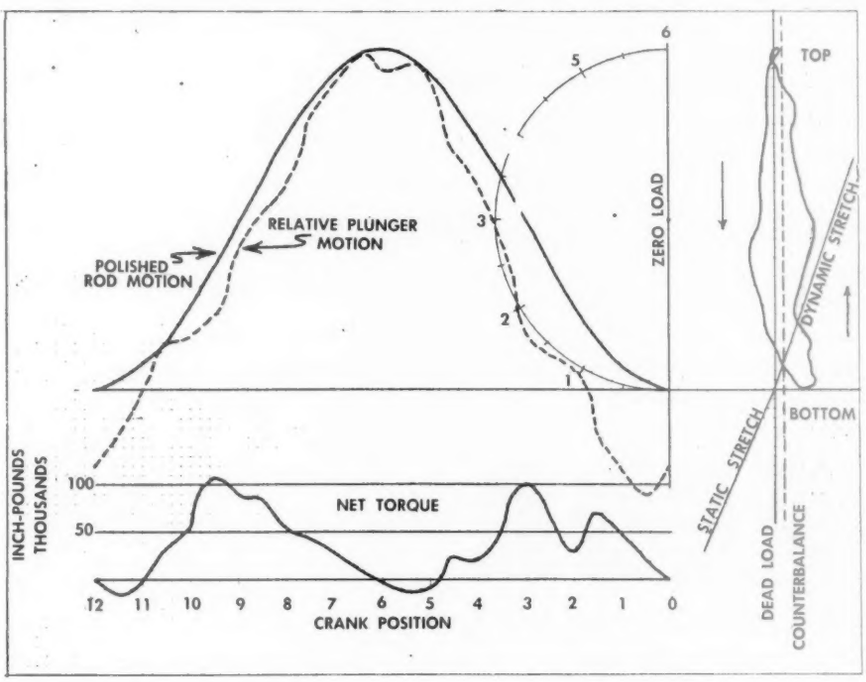
Max. load	18,750
Min. load	6,110
Av. up load	17,100
Av. down load	8,630
Polished rod horsepower	15.05
Peak torque	186,000

It was felt that a stuck plunger was causing the excessive loads. Examining of the card disproved this theory inasmuch as if it were a case of sticking plunger, the card would reflect very little horsepower consumption per stroke.

The card indicates smooth plunger motion and very clearly shows the stretch in the rods. All harmonics have been dampened by the wax.

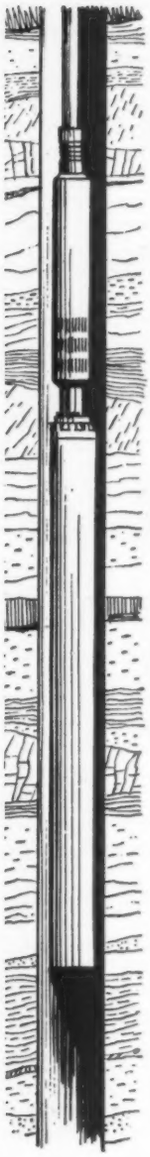
This is a good example of friction in rod string showing up as relative plunger motion.

The power consumption per stroke was only 15.05 hp, but the peak horsepower was much higher. Assuming a power factor of one, and using the am-



Extension No. 1, Turner Valley. Stroke, 64 in. SPM, 13. Depth 7910 ft.

FIG. 4. Dynamometer interpretation — March 15, 1952



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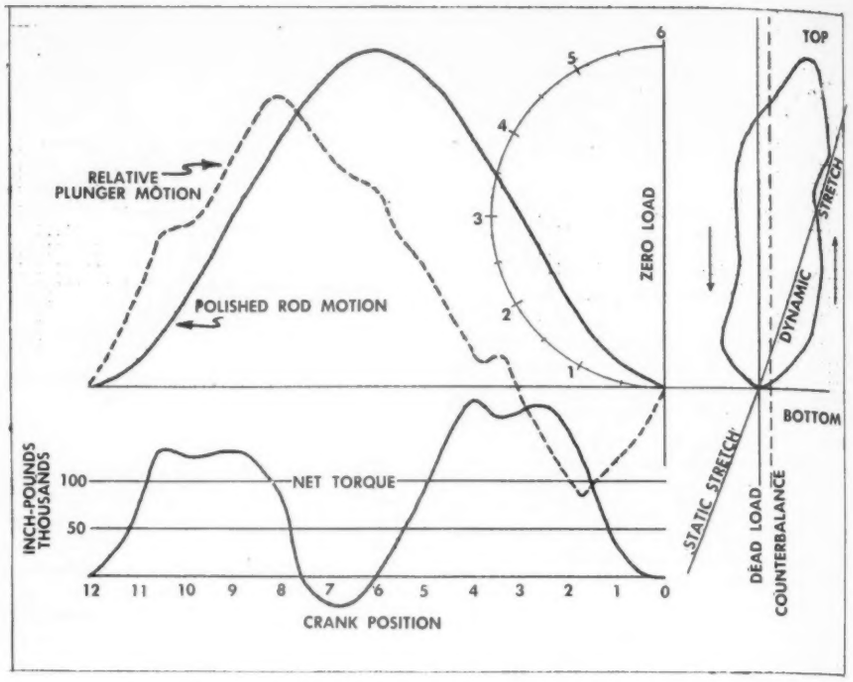


Extension No. 1, Turner Valley. Stroke, 64 in. SPM, 11.5. Depth, 7910 ft.

FIG. 5. Dynamometer interpretation — April 11, 1952.

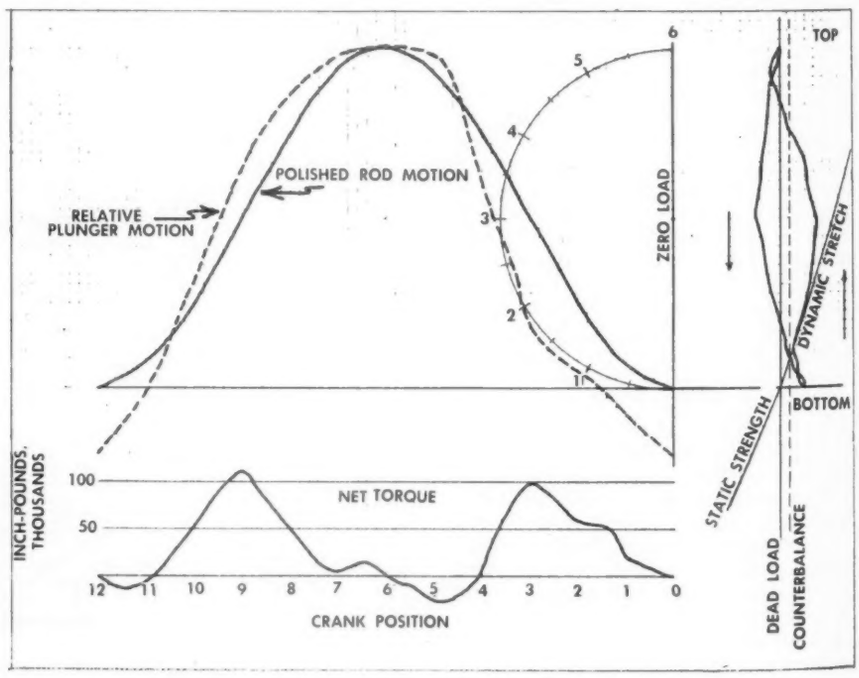
meter readings, the peak horsepower was 35.3.

A service rig was called in and trouble was experienced in unseating the pump. In order to reduce the possibility of exceeding the yield point of the rods two weight indicators were used. Solvent and naphtha were lubricated into the tubing in an effort to loosen the wax. The pump was finally unseated at 30,000 lb.

Two days were taken to pull the rods and pump through the paraffin accumulation. The heaviest wax was from 1900 to 2700 ft. During the above operation, due to the inaccuracy of the weight indicators, 58¾ in. rods were pulled past the elastic limit, measuring in excess of 26 ft. All 2½-in. tubing was pulled, the badly waxed joints laid down and cleaned with hot water and steam.

The subsurface pump was examined and proved to be in excellent condition. "Gyp formation" was in evidence at both ends of the barrel. One travelling valve seat and one travelling valve were slightly pitted. The hold down seating seal and all valves and seats were replaced, although not entirely necessary.

The tubing and rods were re-run, the rods being equipped with an additional 2000 ft of scrapers. The damaged ¾



Extension No. 1, Turner Valley. Stroke, 64 in. SPM, 11.5. Depth, 7910 ft.

FIG. 6. Dynamometer interpretation — May 13, 1952.

in. rods were replaced with rods of a higher tensile strength, as it was felt that these rods would provide a margin of safety in the event of another rod job.

The pump was seated and the unit placed in operation, but failed to deliver. It was then decided to pull all the rods and tubing. Inspection of the tubing failed to reveal any leaks.

The seating shoe showed some evidence of the presence of scale, and it was felt, finally, that this had prevented proper seating of the pump. The bottom 6 to 8 in. of the "mosquito bill" was coated with ¼-in. of gyp and some of the perforations were plugged. The perforations were cleared and the bull nosed end of the "mosquito bill" was removed.

Upon re-running the tubing and rods the pump was primed and immediately started to deliver.

Card Under Present Pumping Conditions 11½ strokes per minute: (See Fig. 6)

Max load	16,050
Min. load	9,020
Av. up load	14,300
Av. down load	10,920
Polish rod horsepower	6.3
Peak torque	119,000

Production has increased from an average of 54 bbl per day to an average of 75 bbl per day, which resulted in an increase in the peak torque from 96,500 at 11 strokes per minute to 119,000 at 11½ strokes per minute. Correct counterbalancing would reduce the peak torque to about 110,000 in. lb. Smooth plunger motion again indicated the absence of detrimental harmonics and operation at this speed should result in long rod life.

It is interesting to note here that if the stroke were 72 in., as indicated by the card, it would represent a pump efficiency of 71 per cent. Assuming the plunger is stroking the same as the polished rod, pump efficiency would be 81 per cent. If one were to take the calculated plunger stroke of 54 in., pump efficiency would be 100 per cent.

Feasibility

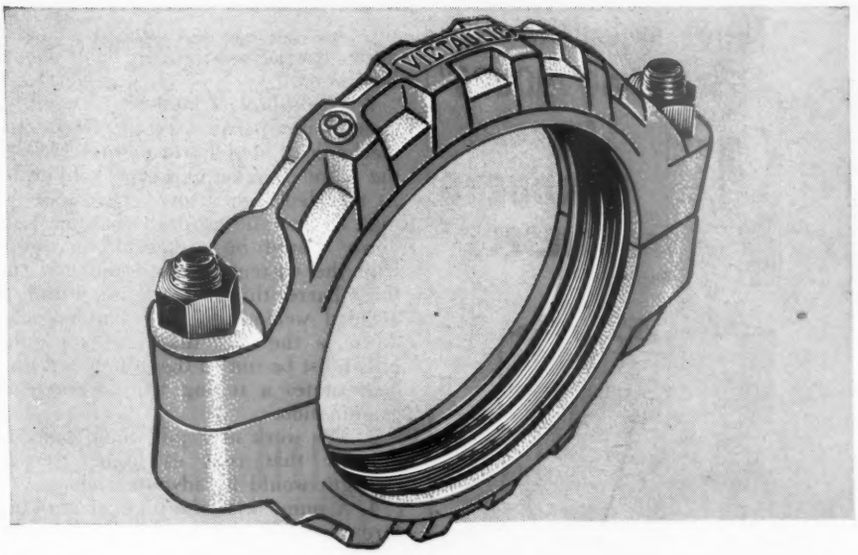
After operating for nearly six months with but one major workover job, it is felt that with a little additional experience deep well pumping in Turner Valley is both feasible and reasonably trouble free. In the first five month period the well pumped at an average rate of 54 bbl per day, and since the workover job has averaged 75 bbl per day under more steady conditions and at slightly higher pumping speed.

As the sale value of the gas (previously flared) more than covers the cost of the lubricants and power it would seem to indicate that rod pumping, where applicable, is cheap.

Recommendations for Further Installations

1. For stripper wells, at this depth a 20,000-lb beam and 160,000-in. lb peak torque gear box would seem adequate. Units of slightly longer stroke would tend to reduce the number of reversals and thus lengthen the life of the rods.

Due to the short anticipated life of



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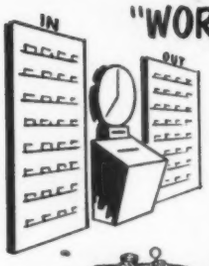

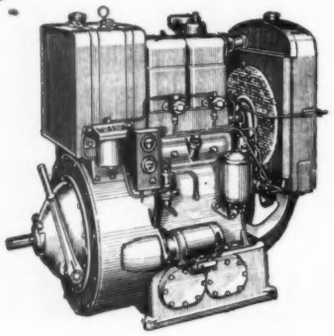

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these stripper wells, units of standard design and of use in other fields should be chosen.

2. The choice of hold-downs is still a moot point. Because of the depth, the mechanical hold-down is preferred to the more common cup type hold-down. At this depth, in theory, because of the high hydrostatic head, the bottom hold-down should be preferable, however, with the extremely small plunger and thick barrel this is not so important. A decided weakness of the bottom hold-down is the fact that the "mosquito bill" must be run on the tubing and thus necessitates a tubing trip to make an examination.

3. The work over job would seem to indicate that rods of higher tensile strength would be advantageous.

4. A pump with the plunger stroking through the barrel would eliminate the possibility of gyp formation in the pump barrel.

5. Although the electric motor is protected against overloading by heaters, it is recommended that a pressure cut-out switch be added to future installations. This would not be necessary if the safety pop valve were entirely sufficient, but in one instance last winter when the flow line was frozen the stuffing box blew up due to the excessive pressure.

Appendix

Since this paper was presented an additional four wells have been placed on the pump. They are:

1. Federated Petroleums Pacific No. 6—a pumping unit[3] with a 24,000-lb beam load and 228,000-in lob API peak torque.

2. Federated Petroleums Chinook No. 2—a pumping unit[3] with a 21,000-lb beam load and 228,000-in. lb API peak torque.

3. Commonwealth Service and Supply Commoil No. 1—a pumping unit[3] with a 21,000-lb beam load and 160,000-in lb API peak torque.

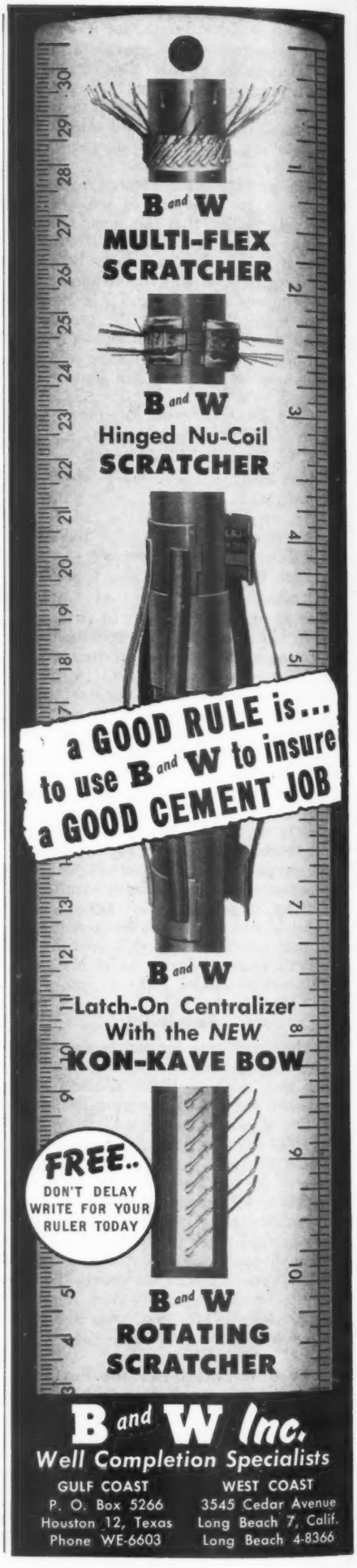
4. Royalite Oil Company, Royalite No. 79—a pumping unit[4] with a 32,400-lb beam load and a 324,000-in lb API peak torque.

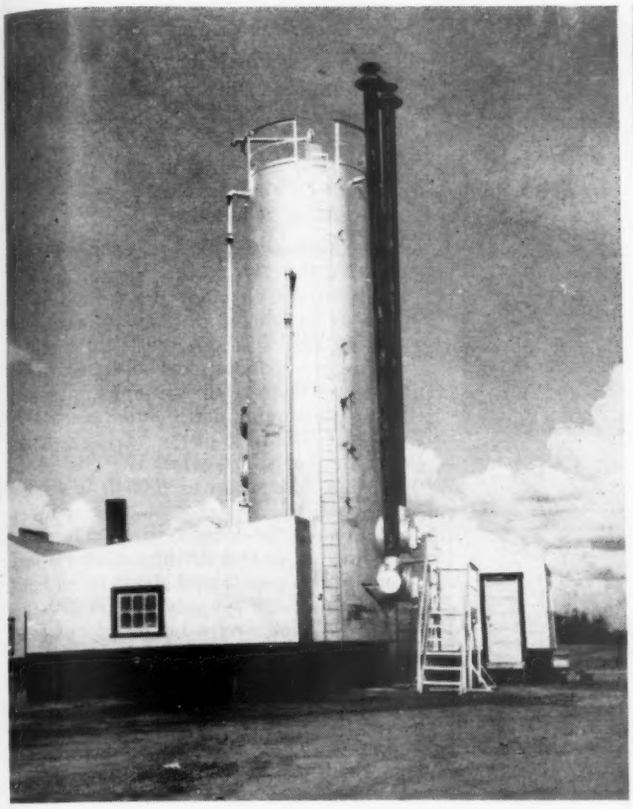
Although it is still a little early to present reliable production figures, production in all cases has proved satisfactory and flush rates as high as 300 per cent in excess of the previous flowing rate are not uncommon.

The Anglo Canadian well, Extension Royalties No. 1 described in the paper has been in operation for 10 months, and operation has been relatively trouble free. From November 1, 1951, to August 31, 1952, the well has produced 16,310 bbl of fluid of which 15,243 bbl were oil. By extrapolating the flowing curve it is estimated that in the ten month period of pumping (actually 9, as the unit was down nearly a month due to the workover job) an estimated additional 9600 bbl of oil has been produced. In this same period 51,942,000 cu ft of gas previously flared has been sold and the revenue thus realized has more than paid for the operation of the well.

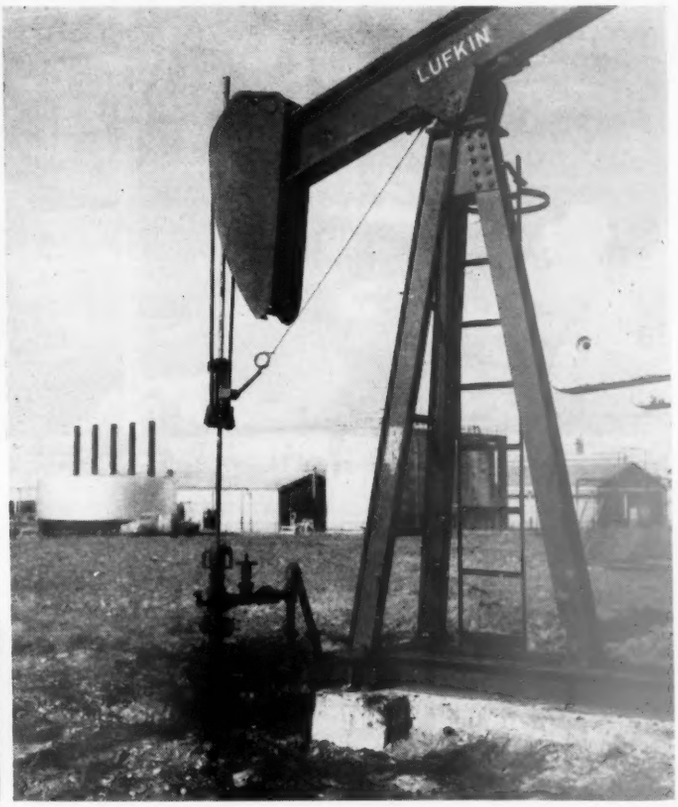
[3]National.
[4]Lufkin.

* * *





Some 2000 bbl water are produced per month in Imperial's Leduc-Woodbend operations. A special salt water treater is provided.



Pumping from the D2 limestone in Imperial Leduc No. 239. Top of pay is approximately 5000 ft, and gravity of the oil is 38 to 39 deg API.

Operations in the Leduc Field Today

High speed rotational drilling is found to be the most satisfactory — proved recoverable oil reserves exceeds 180 million barrels

JACK MENNEER*

The Leduc field, which is now called the Leduc-Woodbend field, is situated near Edmonton in the Province of Alberta, Canada. The discovery well, Imperial Leduc No. 1, was drilled by Imperial Oil, Ltd., in 1947, a date long to be remembered in Canadian oil history.

Rotary table speeds up to 270 rpm are employed for drilling down to 4000 ft, and rapid rates of penetration are recorded. Anhydrite formations require special mud treatment and a gyp based mud is used.

The main production is obtained from two separate limestone reservoirs, the D2 and D3, with a small amount from higher localized stratigraphic sandstone traps. The limits of the D3 pool have been defined, but those of the D2 are still to be determined. A restrictive policy is necessary due to the present unavailability of sufficient market outlet.

The Leduc-Woodbend field already has about 1000 wells, and drilling is still in progress. Imperial Oil, Ltd., and many individual operators are engaged in developing and expanding this great Canadian oil field.

*Editor *Drilling and Producing.*

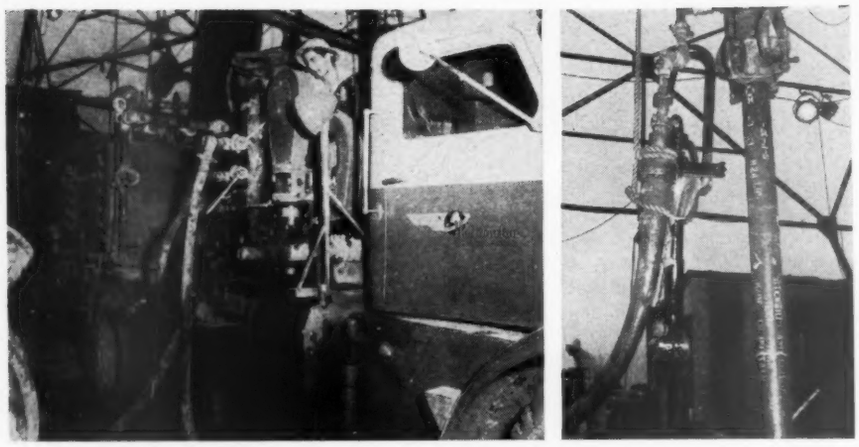
FROM the now fabulous and historical Leduc discovery that was made in the Province of Alberta by Imperial Oil Ltd. on February 13, 1947, a Western Canadian major oil field has developed. Almost a thousand wells have penetrated the Devonian limestone pays, and the entire limits of the field have not been defined as yet. A 40-acre well spacing program progresses and Imperial is the largest operator.

The Leduc, which now includes the Woodbend field, consists of two Devonian reef type limestone reservoirs that are entirely separate. The upper zone at approximately 5000 ft is the D2, or Nisku, and the lower one at about 5300 ft is the D3, or Leduc. The Viking sand occurs at 3500 ft and at 4200 ft the Lower Cretaceous is found, and the possibility of production from this latter zone shows some sign of promise. The non-commercial D1 lime is at 4500 ft. Originally the Woodbend field was considered individually from the Leduc, but further development proved the assumption incorrect. The fields are common to each other and the general name given the combination is Leduc-Woodbend.

EXCLUSIVE

Drilling Techniques

The development calls for a 40-acre well spacing pattern, and the drilling techniques vary slightly among the va-



Cementing the 7-in. casing in Imperial No. 97, Leduc-Woodbend field.

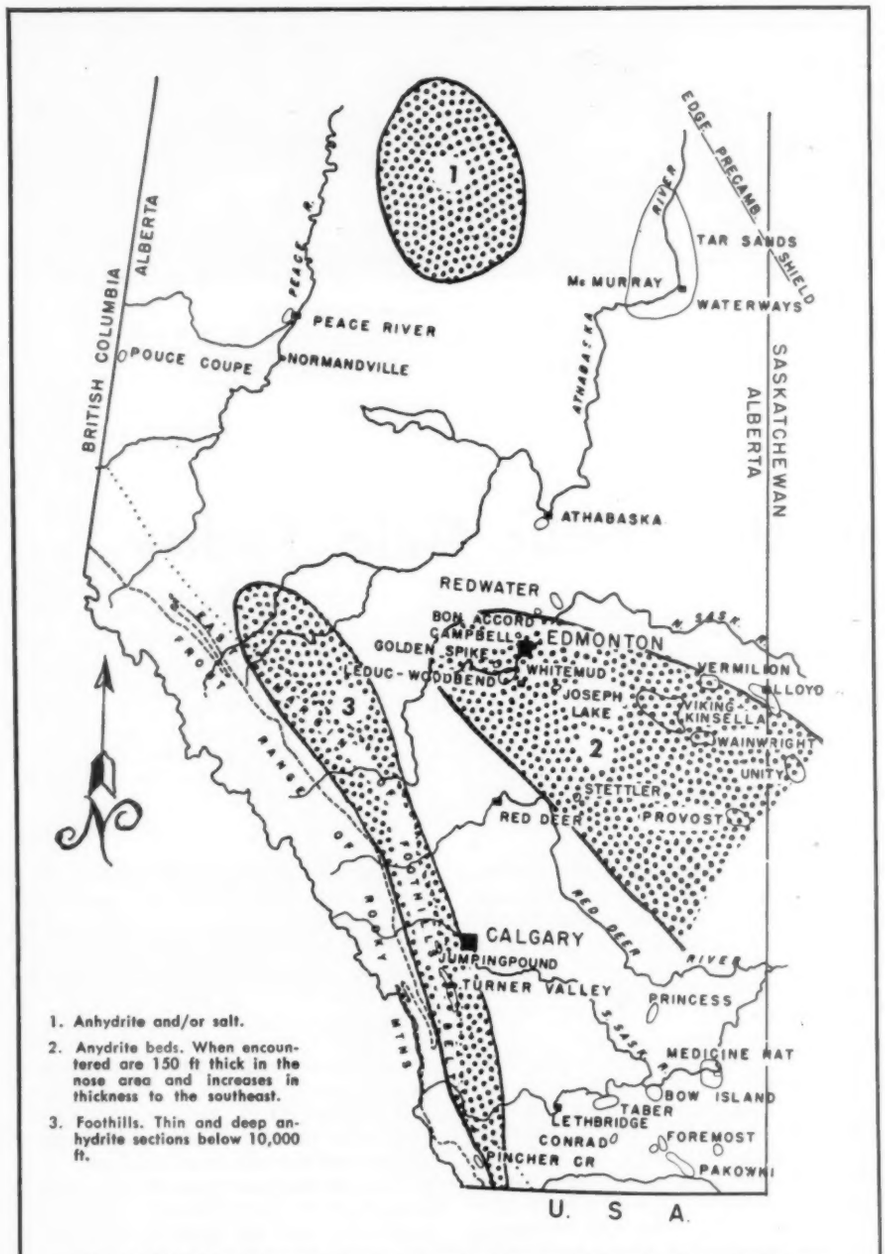


FIG. 1. Western Canada. Areas of anhydrite and/or salt. These beds are usually deep seated. Special gyp mud treatment is the answer in drilling this type of formation.

rious operators, and those as practiced by Imperial will be discussed.

The procedures for drilling a well in the Leduc-Woodbend field are summarized as follows:

1. Surface to 4000 ft.
2. 4000 ft to total depth.
3. A D3 completion.
4. A D2 completion.

1. *Surface to 4000 ft.* From the surface to the top of the Viking sand at 3500 ft and through it to 4000 ft no serious problems are encountered. The Viking sand is about 120 ft thick and is composed of loosely consolidated shales and interbeds of cherty sandstones with some glauconite and bentonitic material present. The base of the Viking member is a zone of silty shales. The cost of the drilling fluid down to 4000 ft is 4 cents per foot, the low cost being largely attributed to the formational bentonite.

Down to 4000 ft drilling rates are fast, one bit has penetrated 204 ft in an hour. High rotational speeds of 250-270 rpm are aimed at, and a bit weight of from 16,000 to 18,000 lb is maintained, and a variation of 1 to 3 seven-inch drill collars are carried. It has been determined that the highest rate of penetration is obtained when a fast rotational speed is adopted.

On meeting the Viking sand at about 3500 ft the rate of penetration is markedly decreased to 12 ft per hour when the conventional bit is used. The weight carried on the bit from this stage is 20,000 lb and 120 rpm, and 1 to 3 drill collars are employed.

Surface casing, 10¾ in., is set at 300 ft and from this point a natural clay base mud is used. Mud weights begin at 8.3 lb per gal (water) and are increased progressively to 11 lb per gallon down to 4000 ft, viscosities are similarly increased from 30 to 35 sec (Marsh). The adherence to the low viscosity rule pays dividends in the form of increased penetration rates. The water loss values range between 10 and 15 ccs, and pH fluctuates around 8 and 9, and the sand content is low, with a maximum of 2 per cent.

2. *From 4000 ft to total depth. (Gyped mud).* Some operators consider that the carrying of up to 10 drill collars is advantageous when drilling below the Viking sand, with 70 rpm as a maximum speed, and a bit weight of up to 35,000 lb. The weight is increased to 38,000 lb for drilling the basal quartz sandstone.

Below the Viking sand is the Blairmore formation (see Fig. 2), which consists of a coaly, glauconitic sandstone and shale. Penetration rates in this section down to the basal quartz sandstone average 11 ft per hour, 100-110 rpm, and 25,000 lb on the bit. The basal quartz sandstone is the lower portion of the Blairmore, it varies in thickness from 175-350 ft, and is the slowest drilled section. Only 3 ft per hour is obtained and 100 rpm and a maximum bit weight of 35,000 lb are maintained.

At 4000 ft the mud viscosity is increased to 42 sec (Marsh) and at 4300 ft a conversion to a gyped base mud is made in order to cope with the anhydrite formations below 4600 ft.

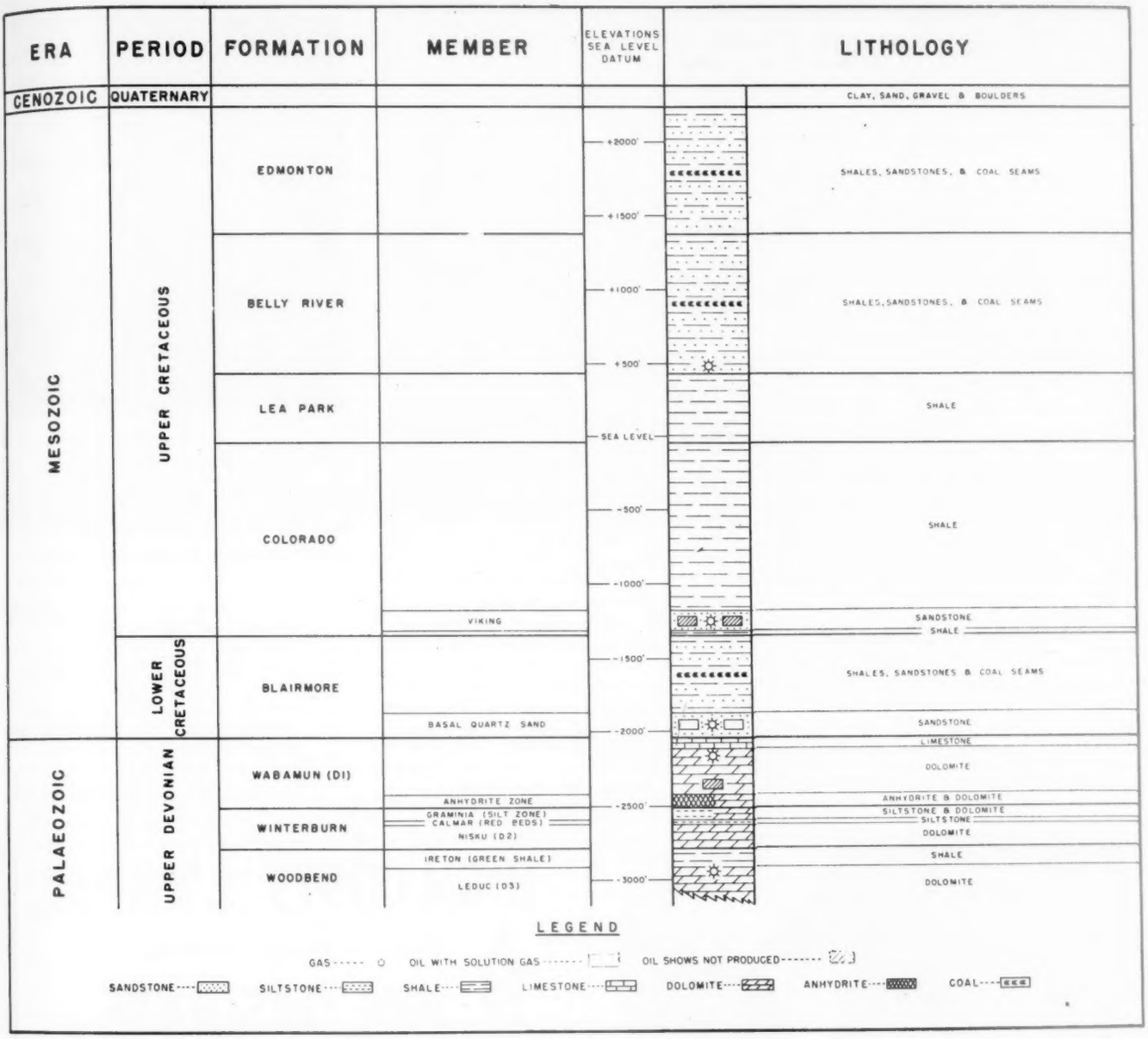


FIG. 2. Generalized geological section of Leduc-Woodbend field.

Anhydrite and/or salt beds occur in many parts of the Prairies (see Fig. 1), and in the Leduc-Woodbend two particular zones are found, namely a) the Upper, and b) the Lower.

a. Upper Anhydrite.
This is composed of bedded anhydrite and increases in thickness from 10 to 126 ft in a southwestward direction.

b. Lower Anhydrite.
A 65 to 85 ft thick layer of finely crystalline to dense silty dolomites is interbedded with a somewhat silty anhydrite.

To have a gyped base mud, watering back to a low viscosity of say 35 sec (Marsh) is the first prerequisite. A 2-in. stream of water is turned into the mud canal and one sack of plaster of paris is mixed every 4 min. The total amount of plaster of paris required for the breakover is calculated on the basis of 3 lb per barrel of mud. The next step is the addition of the starch preservative, and one sack is mixed every 12 min for the first 20 sacks, and 8 min per sack for a further 20 sacks.

To prevent starch fermentation, 300

Preparing to run a diamond bit at the Castle-Leduc-Albadene well No. 15-3 in Leduc-Woodbend field. Roberts Drilling Company are the contractors.

FIG. 3. General comparison of conventional and jet bit performance in the Leduc-Woodbend field.

Formation	Conventional bit, feet per hour	Weight (lb) Rpm Drill collars	Jet bit, feet per hour	Drill collars	Jet bit, per cent increased penetration
Viking	12	20,000 120 I-3	19.4	20,000 70 10	62
Blairmore	11	25,000 100—110 I-3	22.5	25,000 70 10	105
Basal Quartz	3	35,000 100 I-3	11.3	35,000 70 10	277

Core showing the vuggy porosity in D3 limestone (Biohermal reef). Average porosity is 10 per cent (estimated), and the permeability is high. The connate water content is approximately 13 per cent.

lb of formaldehyde is added. Daily maintenance of the mud requires small additional amounts of the various components, and a water loss of from 5 to 8 ccs is sought. This type of mud is used from 4300 ft to the setting depth of the 7 in. casing.

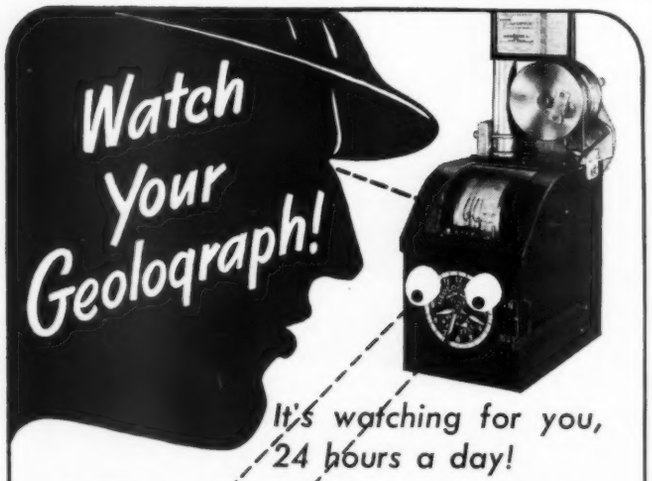
Penetration and Deviation

Figures have been given only for rates of penetration of conventional bits, and it is of importance to consider for a moment the comparative performances of jet bits in the Leduc-Woodbend field.

On referring to Fig. 3 it is observed that increased rates of drilling were achieved with the jet bit in conjunction with the adaptation of 10 drill collars. The results were as follows: Viking sand 19.4 ft per hour, or an increased rate of 62 per cent; Blairmore formation 22.5 ft per hour, or 105 per cent increased penetration; Basal quartz 11.3 ft per hour, or 277 per cent increase. These increases are considerable and speak highly of the jet bit operations.

The general drilling procedure adopted may be summarized according to the two types of completion.

1. For a D2 completion.
   In the drilling of the D1, anhydrite, silt, Red beds, D2, and green shale the average weight carried is 32,000 to 38,000 lb, 100 rpm, and 1 to 3 drill collars are used. With 10 drill collars the revolutions per minute would be 70 and the same amount of weight (32,000 to 38,000 lb) would be carried on the bit.
2. For a D3 completion.
   Because the 7-in. casing is set



- Minutes Per Foot
- D.S.T. Packer Points
- Round Trip Time
- Net Pay Thickness
- Formation "Breaks"
- Connections
- Accurate Coring Points
- Correlation "Tops"
- Feet Per Hour
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Separator installations in Imperial Leduc-Woodbend Battery No. 7. Average separator GOR for the D3 limestone is 600 cu ft per bbl.

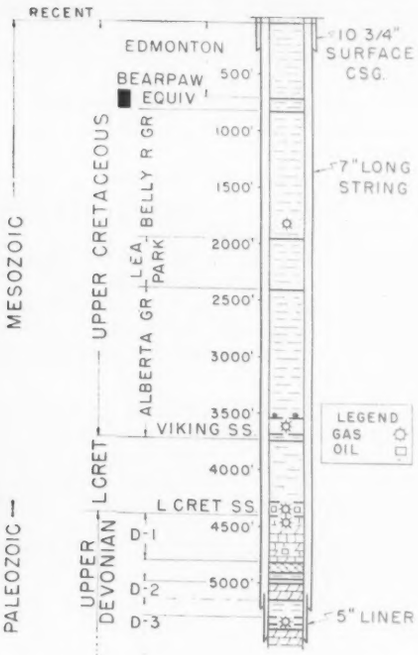
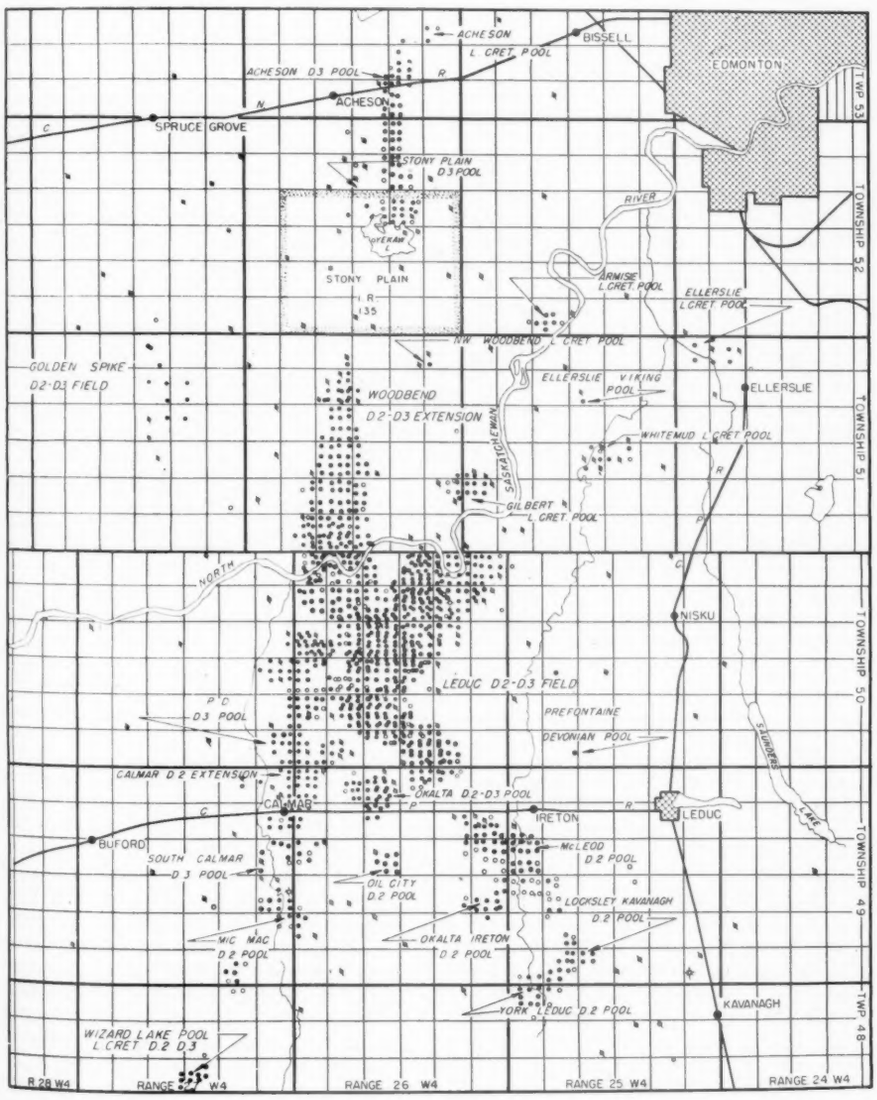


FIG. 5. Leduc Geological section showing casing program for D-3 zone.

FIG. 4. Leduc-Woodbend field, Alberta, Canada.



above the pay zone, 3½ in. drill pipe is employed and one 5¾ in. drill collar is carried in making a 6¼ in. hole.

Crooked hole problems do not occur in the Leduc-Woodbend field and a deviation in excess of one degree is uncommon.

Completion Methods and Costs

Two producing zones exist, namely the D2 and the D3, and various completion methods are followed.

1. D3 Completion. (See Fig. 5.)
   a. Open hole
   b. Open hole with packer set in open hole.
   c. Liner.

Lost circulation frequently occurs in the characteristically vuggy D3 lime, and because of a previously serious blowout the Conservation Law requires the setting of the oil string in the green shale, which overlies the D3 (see Fig. 2).

In the above mentioned completion practices the well is washed with approximately 500 gal acid, and then swabbed into production. If the pay is tight, several acid washes may be necessary and selective acidizing may be applied.

2. D2 Completion.
   Two methods are used for completing this zone.
   a. Open hole.
   b. Set casing through zone and perforate.

Acid washing and possible selective acidizing are performed for bringing the well into production. The average cost of a D2 well is $60,000, which includes some $12,000 for completion

costs and equipment. A D3 well would be $79,000 with a similar inclusive of $16,000.

Rigging up costs are substantially reduced in either type well, as about 90 per cent of the drilling rigs engaged in penetrating the reservoirs have a jackknife type derrick.

Leduc-Woodbend Reservoir. the field consists of several reservoirs in different formations (see Fig. 2):

1. Leduc D3 — Woodbend formation — Upper Devonian.
2. Nisku D2 — Winterburn formation — Upper Devonian.
3. Lower Cretaceous — Blairmore formation.

The D3 pool is overlain by the D2 throughout most of its area and twin wells are usually drilled in the center of each 40 acres. Dual completions have been made on a few locations since early 1951.

(1) Leduc D3 (Biohermal). Average depth 5300 ft.

The maximum thickness of the Devonian dolomitic limestone reef at the crest is about 1400 ft with a 38-ft oil column. The volume of the gas cap is 1.4 times that of the oil zone, and the oil-water contact is level at 3020 ft subsea.

The areal extent of the reservoir is approximately 22,000 acres with an average pay thickness of 31.5 ft. Core recovery is poor due to the vugginess of the biohermal reef and an estimated porosity is approximately 10 per cent. The shrinkage factor is 0.685 stock tank barrels per reservoir bbl and the estimate for the connate water content is approximately 13 per cent. The original bottom hole pressure was 1894 psi, and was 1785 on January 1, 1952.

The proved original recoverable oil is considered to be about 162,500,000 bbl; a 50 per cent estimated recovery factor is assumed. The separator gas oil ratio has increased from 500 to 600 cu ft per bbl during the present 5½ yr life of the pool, and to date the water production is negligible.

The mechanics of recovery is the combination of a strong bottom water drive and an expanding gas cap. The June 1952 maximum permissible rate (MPR) of production from some 425 wells was 40,000 bbl oil per day, 38 to 39 gravity, but due to proration is of the order of 30,000 bbl. (As a point of interest, the Conservation Board of Alberta exercises penalties for excess gas or water production and these are scaled in accordance with Figs. 6 and 7.)

(2) Nisku D2 (Biostrome). Average depth 5000 ft.

The limits of the extremely variable D2 reservoir have not been finally determined as yet. The oil accumulation is due to both structure and porosity variations, and the present area is some 29,500 acres with an average pay thickness of 63 ft.

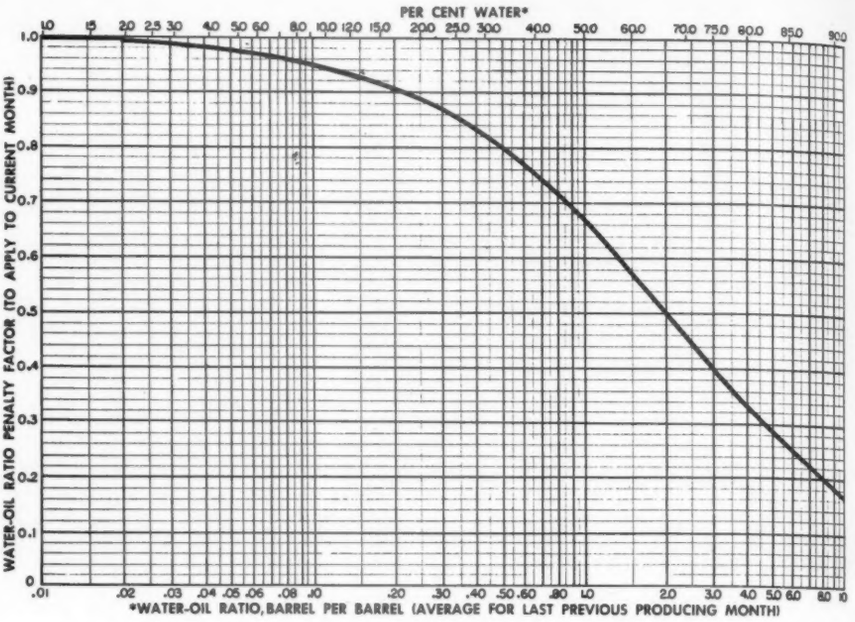
The average porosity is 3 per cent and an average permeability is 20 md. The shrinkage factor is 0.682 stock tank barrel per reservoir barrel and the connate water content is 15 per cent (estimated). A small gas cap exists that is not level. The mechanism is mainly gas cap expansion and water encroachment.

The original bottom hole pressure was 1770 psi and the original estimated recoverable oil in place was 62,500,000 bbl with an estimated 30 per cent recovery factor. At mid-1952 there were about 500 (38 to 39 gravity) producing wells in this zone and the reservoir is being actively developed. The Leduc-Woodbent D2 has produced almost 13,000,000 bbl of oil and the maximum producing rate per well per day is 70 bbl.

(3) Lower Cretaceous.

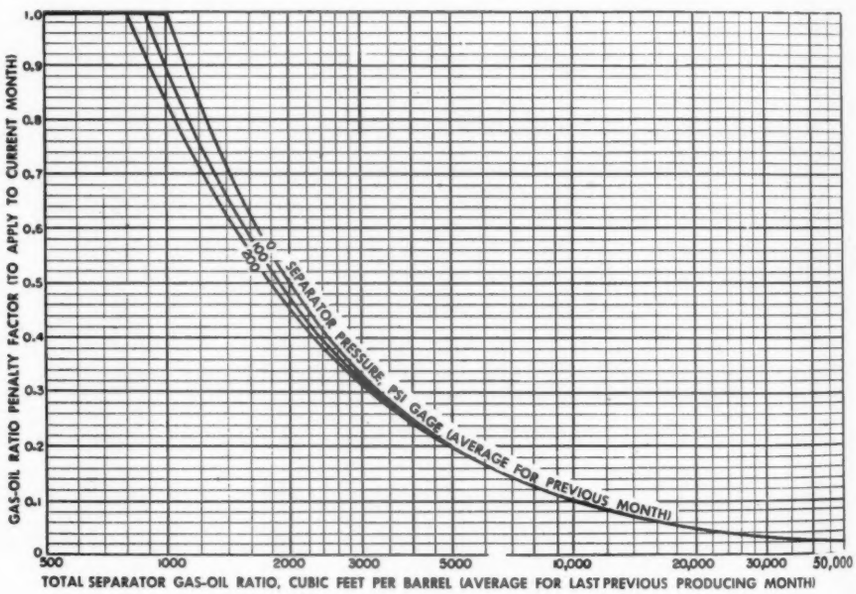
A number of small Lower Cretaceous pools are widely scattered over the area and have individual acreages from 100 to 500 with a thickness from 5 to 25 ft. These small isolated reservoirs are stratigraphic traps that generally have a gas cap and the oil is 39 to 40 gravity.

The great quarter of a billion barrel Leduc-Woodbend field still has a conservative 84 per cent of proved recoverable reserves — this is the field that did so much for the Canadian oil industry. As can be seen, much remains to be added. * * *


PER CENT WATER*
WATER-OIL RATIO PENALTY FACTOR (TO APPLY TO CURRENT MONTH)
*WATER-OIL RATIO, BARREL PER BARREL (AVERAGE FOR LAST PREVIOUS PRODUCING MONTH)

*NOTE: Water must include all water and BS & W produced by well.

FIG. 6.


GAS-OIL RATIO PENALTY FACTOR (TO APPLY TO CURRENT MONTH)
0
100
200
SEPARATOR PRESSURE, PSI GAGE (AVERAGE FOR PREVIOUS MONTH)
TOTAL SEPARATOR GAS-OIL RATIO, CUBIC FEET PER BARREL (AVERAGE FOR LAST PREVIOUS PRODUCING MONTH)

NOTE: In event of multi-stage separator operation use the curve corresponding with the lowest separator pressure.

FIG. 7.

Drilling and Producing

CANADA SETS RECORDS FOR 1952

Operators plan to spend $400,000,000 to expand industry in 1953, almost double the cost of expansion in 1952

LARRY F. FRANTZ*

RECORDS tumbled in all phases of Canada's oil and gas industry during 1952, with the "pay off," or discovery score for new oil and gas strikes, reaching a rate of one every 48 hours during that year.

Drilling contractors were busy in 1952 making more hole in Canada than ever before in that nation's history. More exploratory (geological, geophysical, and drilling) and development operations were carried out, oil and gas reserves, and production were boosted. Oil and gas transportation projects were mapped out, planned, and commenced during the year, and more companies, both domestic and foreign, were pouring out monies at a new rate, and also were receiving revenue from production at an all time high.

Exploration on the plains and in the foothills of the four western Canadian provinces during 1952 has yielded 180 indicated discoveries in the west. Unfortunately all the new strikes are not of commercial calibre, and a number of the indicated discoveries in the score have either been abandoned, suspended, capped, or require additional testing to evaluate fully their ultimate significance. Indications are, however, that among the 1952 discoveries, are several major oil and gas reserves.

There are currently more than 275 rotary rigs in Canada. Year end tally showed 226 active; 108 are at or are moving to wildcat sites, and 118 are on development.

Discoveries

More than 50 per cent of the new finds, or 93, are oil discoveries. Sixty-nine are discoveries of dry gas, while the remaining 18 are wet gas discoveries.

Seventy-five per cent of the 1952 discoveries were made in Alberta, Canada's No. 1 petroleum province. In that tally, 135 in all, are 61 oil discoveries, 62 dry gas strikes, and 12 new wet gas finds. Included in the Alberta discoveries are Bonnie Glen-Pigeon Lake, oil and wet gas; New Norway, Erskine, West Drumheller, Nevis, Okotoks, and others. As is the case with the other three provinces, numerous extensions and step-out drillers in oil and gas field regions were successful and extended proved limits of a number of fields, and also boosted the nation's oil and gas reserves.

Saskatchewan wildcats came through with 30 strikes during the year, which include 23 oil, and 7 gas discoveries, such as Fosterton, Cantuar, Eastend, Ratcliffe, and Wapella.

Drilling in British Columbia brought the industry 11 new finds, primarily in the northeast sector of the province, and specifically in the Fort St. John region, which is rated as a major wet gas reserve. Five of the British Columbia strikes were oil discoveries and the balance was wet gas wells.

Southwestern and south central Manitoba, in the northeast rim of the Williston Basin, chalked up four light gravity oil discoveries, all in the Missisippian formation. That province, which received its initial commercial oil production in 1951, was producing at a rate in excess of 1100 bbl daily by year's end.

Drilling

During 1952 there was a flurry of rig purchases by contractors expanding their Canadian operations, by oil companies carying out their oil drilling operations, and by newly formed contracting firms. Unfortunately the shortage of steel tubular goods in Canada forced shutdown of a number of rigs for a lengthy period, and estimates of the number without drilling contracts, when the effects of the U. S. steel strike were at a peak, were in excess of 60 rigs. There are currently more than 275 rotary rigs in Canada, with year-end tally showing an active 226 rigs. Of those, 108 are at or moving to wildcat sites, while 118 are carrying out development of established fields. Just prior to the Leduc 1947 discovery, there were 20 rigs at work in Canada.

Alberta, where the lion's share of Canadian drilling is undertaken, had 170 rigs operating within its border, on December 31, and during 1952 had accounted for the drilling of 1573 wells (922 oil, 121 dry gas, 17 wet gas, and 513 dry holes), which amounted to more than 6,500,000 ft of hole (a 16 per cent increase in footage compared with 1951).

On December 31, there were 36 rigs operating in Saskatchewan, 12 in British Columbia, and 8 in Manitoba.

At mid-year, there was a peak of 253 rigs on the active list in Western Canada. These were distributed as follows: Alberta — 73 at wildcats, 136 at field wells; Saskatchewan — 22 at wildcats, 9 at field wells; British Columbia — 6 at wildcats, one at a field well; and Manitoba — one at a wildcat, 5 at field wells.

Geophysical

Wells were completed at the rate of nearly six daily last year, as drilling in the four western provinces of Canada

*Co-editor Daily Oil Bulletin.

EXCLUSIVE

accounted for the completion of 2150 wells, including 1177 oil producers, 138 dry gas wells, 27 wet gassers, and 808 dry and abandoned wells.

The major share of drilling activity was in Alberta, where 1573 holes were completed (922 crude oil wells, 121 gas wells, 17 wet gas wells and 513 dry holes.) Saskatchewan was in second position, with less than one-third the number at Alberta, or 488 wells (214 oil, 17 dry gas and 257 abandonments). Manitoba, primarily in the southwest sector, chalked up 40 new oil wells and 34 dry holes in the 12 months; while British Columbia showed one completed oil well, 10 wet gassers, and 4 dry holes. A number of the wet gas wells in British Columbia also showed oil production, but were capped as potential gas wells, awaiting a market outlet.

Geophysical exploration in Western Canada reached a record 185 crews during the latter part of 1952, but decreased to 168 by year end, as many of the oil companies had completed their 1952 program, and were anticipating another banner year in '53. Just prior to the Leduc discovery in Alberta, there were 15 geophysical parties in Canada.

Over 75 per cent of Canadian geophysical operations were in Alberta during December, as 127 of the total units were operating in that province, including 120 seismic units and 7 gravity crews. All through the past year, Alberta was second only to Texas on the North American continent, in terms of geophysical activity.

Saskatchewan had 31 crews engaged during December, 29 seismic and 2 gravitymeters. Manitoba recorded three seismographs, while British Columbia's accelerated program had boosted its tally up to 6 seismic units and an airborne magnetometer.

According to latest available information, there were 38 "slim hole" rigs operating in the plains area of western Canada, a slight reduction compared with reports received in November.

Production

The year 1952 boosted Western Canada's oil production approximately 37,200 bbl daily more than during 1951, as estimates at year end place the oil output from the prairies at 167,842 bbl daily. Included in that are 162,956 bbl from Alberta wells, 4584 bbl from Saskatchewan, and 302 bbl from Manitoba. Only production from British Columbia came from wells that were tested, and for all intents and purposes was negligible, as none of the wells are on steady production.

Canada's high production point was recorded during October, when it averaged 198,704 bbl per day. At year end daily average production was 186,350 bbl, including 180,170 bbl from Alberta, 5050 bbl from Saskatchewan and 1130 bbl from Manitoba.

Natural gas production for the year is estimated at 93 billion cubic feet, including 92 billion cubic feet from Alberta fields and the balance from Saskatchewan.

Discovery wells and extension and evaluation drilling in western Canada boosted the nation's oil reserves by 500,000,000 bbl, placing the reserve figure at two billion barrels by end of 1952. In January 1947 the reserve was only 65,000,000 bbl.

Reserves of natural gas were raised more than 3500 billion cubic feet, for a total of 10,500 billion cubic feet on December 31. Ultimately the reserves of both oil and gas will be several times that currently estimated, as Canada is barely touched as far as oil and gas exploration is concerned.

Economics

Transportation of oil and marketing arrangements also received a boost during 1952, as a major $84,000,000 oil pipe line from Edmonton to Vancouver, with a branch line to Washington, was designed and partially constructed. This line, with a planned initial capacity of 120,000 bbl daily and ultimate of over 200,000 bbl per day, is scheduled for completion in August 1953. This Trans Mountain Oil Pipe Line will begin delivering at rate of 75,000 bbl daily, to Vancouver and California.

A major extension of the Interprovincial pipe line, costing in excess of $70,000,000 across Northern Michigan to Sarnia, Ontario, will be completed in the fall of 1953. This line will initially transport 100,000 bbl daily, thus permitting year round delivery of western Canadian oil to Ontario refineries.

Land, exploration, and development in western Canada cost oil operators over $250,000,000 during 1952, a substantial increase compared with the $25,000,000 spent by the industry during 1947. In addition, approximately $60,000,000 was poured into pipe line and refinery construction or expansion during the year. Forecast for 1953, is a total spending that may reach $400,000,000, including land, exploration, development, refinery, and pipe line operations. The initial three phases will account for an approximate $275,000,000 investment, while proposed gas export pipe lines plus the oil lines already mapped and being constructed, may account for the remainder.

Sale of Alberta's oil and natural gasoline brought in an estimated $143,000,000 during 1952. Of that approximately $14,000,000 will be or has gone to the provincial government's treasury, as the province is mineral rights holder on most Alberta lands.

The revenue to both the producer and to the government of Alberta, Saskatchewan, and Manitoba are steadily increasing. Although hundreds of millions are being spent each year, the 300 or more oil companies exploring in western Canada, have so far received but a fraction of their investment in Canada. Their faith, however, in the future of Canada's petroleum industry, and the encouragement so far received — in both oil and gas discovery — in government administration of oil and gas regulations — continue to push them into further exploratory and development operations, which in all likelihood will place them in the receiving position. * * *

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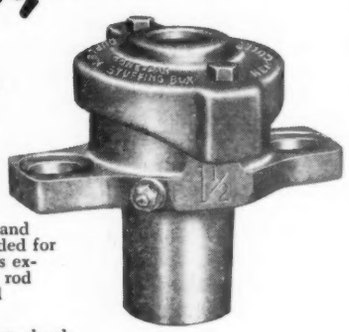

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Reefal Oil Reservoirs in Western Canada

D3 limestone reservoirs produce 65 per cent of area's daily production and have to date a cumulative of 100,000,000 bbl oil

R. POT

ALL the oil containing reefs found so far in Western Canada can be traced back to Devonian time. Beds of Middle and/or Upper Devonian age occur throughout the entire Sedimentary Basin area of Western Canada. The Devonian sediments consist of green to gray shales, bedded limestones, and dolomites, reef limestones and dolomites, evaporites, etc. The greatest crude reserves discovered to date are contained in the D3, also called the Leduc formation, of Upper Devonian age, consisting of reef (biohermal) limestones and dolomites capped by green shales.

Overlying the green shales is the D2, also called the Nisku formation, that consists of bedded (biostromal) limestones and dolomites. Although less prolific than the D3 reservoirs, a sizable portion of the present reserves are in this zone. The caprock of the D2 zone is made up of shales (Red Beds) overlain by silt and anhydrite sections. Above the anhydrite layer lies the D1 zone, also called the Wabamun formation, consisting of bedded (biostromal) limestones and dolomites. Oil saturation in this formation is very spotty and so far negligible reserves have been found in it.

The first reef production was in 1920 in the D3 equivalent at Norman Wells, 80 miles south of the Arctic Circle. Additional reef production was found in the Princess area in 1939, some 120 miles east and south of Calgary, Alberta. Not until 1947, with the discovery of Leduc did it become evident that large reserves were present in the Devonian. So far, the bulk of the Devonian reserves is concentrated in the Central Alberta plains.

Devonian Reef Oil Reservoirs

Table 1 is a list of the more important Devonian oil reservoirs in Western Canada.

Ultimate primary recoverable reserves of the D3 reefs discovered to date are estimated in the order of 1.5 billion barrels of stock tank oil or some 70 per cent of the estimated total ultimate recovery from all horizons so far found productive. Of the almost 3700 oil wells capable of production in Western Canada there are close to 1700 D3 wells. It is interesting to note that Redwater has estimated reserves of some 760,000,000 bbl and is virtually drilled out with 925 wells. Leduc-Woodbend D3 zone with slightly over 162,000,000 bbl has some 550 possible locations of which some 459 have been drilled. Total production from the D3 reservoirs approached 100,000,000 bbl on September 1, 1952, while daily, almost 130,000 bbl were produced or some 65 per cent of the total daily production of Western Canada (August, 1952).

Ultimate primary recoverable reserves of the D2 limestones and dolomites are estimated at some 140,000,000 bbl of stock tank oil or some 6.5 per cent of the estimated total ultimate recovery from all the horizons found to be productive. Some 700 wells were reported capable of production in August 1952. Of these 524 were in the Leduc-Woodbend field, where some 62,000,000 bbl are estimated for recovery. Total production from the D2 reservoirs was almost 19,000,000 bbl on September 1, 1952. Daily production approached 30,000 bbl in August 1952.

The Author

R. Pot is a senior member of the firm of Trafford & Associates, consulting group of Calgary, Alberta, Canada. A reservoir engineer, he joined the Shell Group in Venezuela serving six years as a petroleum engineer. In 1948 he was transferred to the United States to work for Shell in conjunction with the Netherlands army oil program. In 1945 he transferred to Borneo for a year to assist in the rehabilitation of the oil fields there. Pot joined Imperial Oil, Ltd., in Calgary as chief petroleum reservoir engineer, a position he held until joining Trafford & Associates in 1951.

Crude Characteristics

The gravity of the stock tank oil produced from the Devonian reservoirs varies between 28 and 42 deg API, the bulk is somewhere around 35 deg API.

Reservoir conditions vary greatly. Oil occurs in saturated conditions with or without gas cap and in the under saturated state. Large gas caps are present in the D3 reefs of Leduc-Woodbend, Bonnie Glen, Pigeon Lake, and Fiveland. The Leduc-Woodbend D2 zone contains saturated crude with small localized gas caps. Under saturated crude has been reported in the D3 reefs of Redwater, Golden Spike, Acheson, Glen Park, Wizard Lake, and Stettler. Also in the D2 reservoirs of Excelsior, Drumheller, and Stettler.

Solution gas oil ratios vary between 200 and 750 cu ft per barrel of stock tank oil. Viscosities of the crude oil under reservoir conditions range from 0.5 to 3.0 centipoises.

Character of Pore Spaces

Porosity in the Devonian limestones and dolomites varies considerably with respect to absolute value as well as to type.

The D3 reefs are made up of true biohermal material, coral debris, and/or coral sand. Vuggy primary and secondary porosity are present. Also intercrystalline and intergranular porosity. In many cases cracks and fissures are encountered, often in broken and crushed reef material. Good continuity of porosity has been found to exist in practically all D3 reservoirs with permeabilities averaging 300 md. Dense streaks within the oil reservoir are encountered, of course, but they are not continuous over an entire reservoir, so that locally, only the vertical movement of oil is restricted and not the lateral migration to the bore holes. Porosities up to 17 per cent have been recorded in intergranular sections. For vuggy porosity with solution channels porosities vary from 6 to 10 per cent. Reef sections with porosities as low as 2 per cent are not uncommon.

The D2 formation's biostromal limestones and dolomites have a definite lay-

TABLE 1.

Province	Field	Producing formation
Alberta.....	Acheson	D3 and D2
	Bashaw	D3
	Big Valley	D3 and D2
	Bon Accord	D2
	Bonnie Glen	D3
	Drumheller	D2
	Duhamel	D3 and D2
	Excelsior	D2
	Fenn-Caprona	D3 and D2
	Fiveland	D3
	Glen Park	D3 and D2
	Golden Spike*	D3 and D2
	Leduc-Woodbend*	D3 and D2
	Malmo	D3 and D2
	New Norway	D3 and D2
	Normandville	D3 equivalent
	Pigeon Lake	D3
	Redwater*	D3
	Stettler	D3 and D2
	Wizard Lake	D3
Northwest Territories...	Norman Wells	D3 equivalent

* Major oil pools with original reserves over 100,000,000 barrels. If indications prove true that Bonnie Glen and Pigeon Lake are connected then their combined reserves will also be over 100 million barrels.

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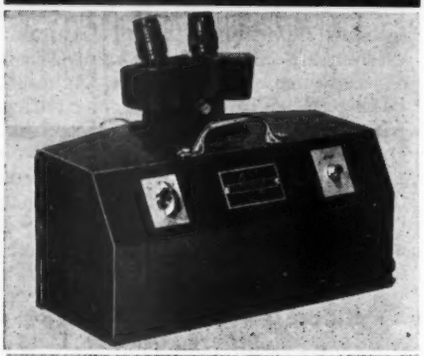

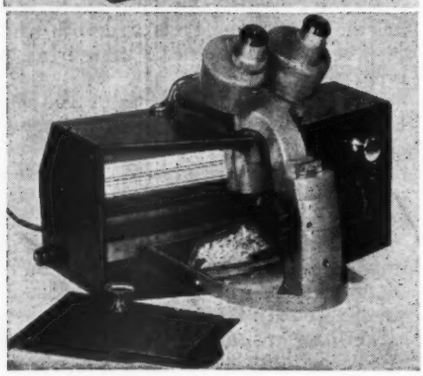

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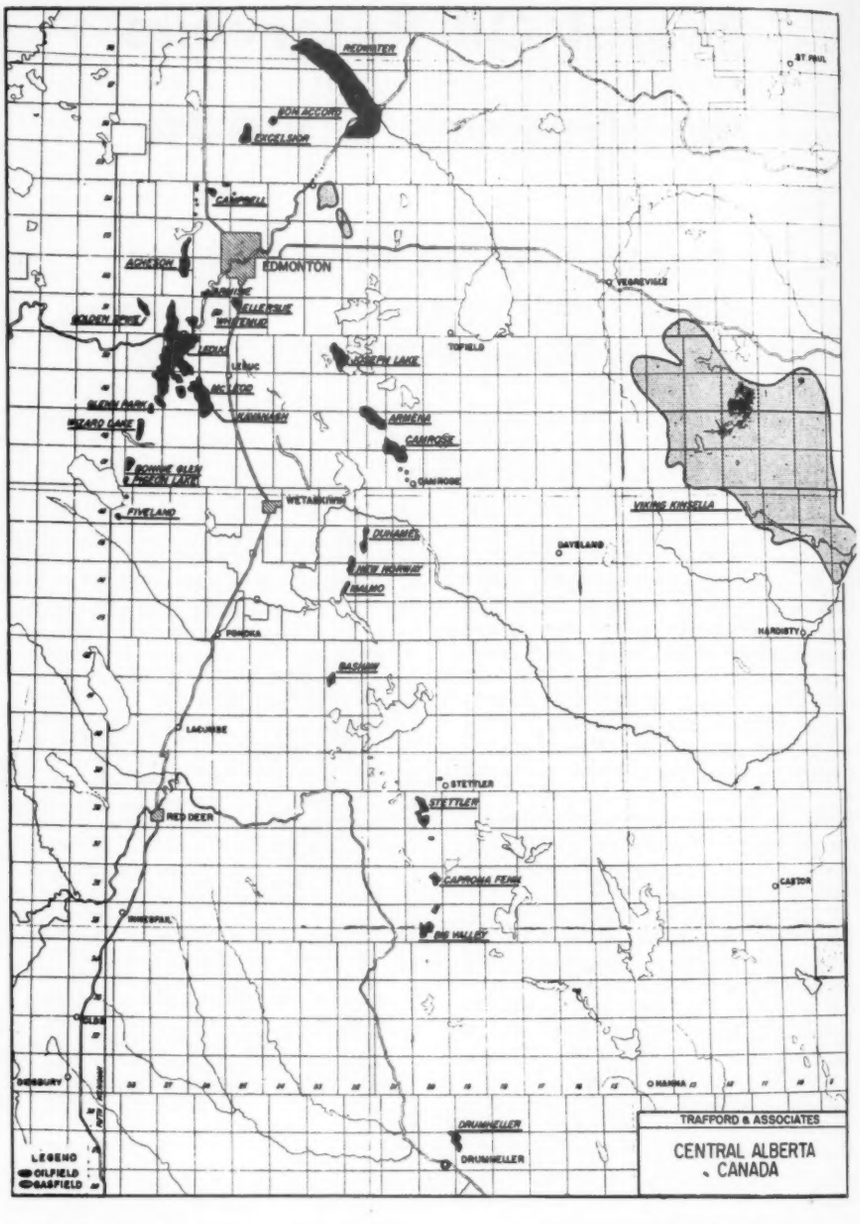

ered characteristic. Porous layers alternate with dense carbonates and silts. Porosity in the porous layers is from intergranular to medium sized vugs in intercrystalline matrix. Often fine cracks are noticed. A great part of the pore spaces are filled with secondary anhydrite. Permeabilities averaging 30 md are substantially lower than in most D3 reef material. The occurrence and disappearance of porosity is a criterion for the oil accumulations in this formation. Productivity of a well is usually not controlled by structural position although a noted exception to this observation is the Excelsior D2 reservoir.

Porosity values in the D2 limestones and dolomites range from 1.0 to 10 per cent.

Quantitative interpretation of the neutron log has given substantial data with respect to porosities of limestones in both D2 and D3 zones over and above the regular large plug core analyses. So far, the interpretation of neutron logs in dolomites, especially when anhydrite fillings are present, has met with little success.

Recovery Mechanisms

In practically all cases the D3 oil accumulations are underlain by water. Usually the oil occupies a small part at the highest point of a large reef structure often more than 1000 ft thick and hundreds of square miles in areal extent. These conditions are favorable for bottom water drives especially as vertical permeabilities are good. To date, only one D3 reservoir has been encountered where waterdrive will not assist substantially in the recovery of oil. This is the Golden Spike pool. A thick, dense band of black limestone stretches all the way across the bottom of the more than 600 ft thick oil body. Water is found beneath this barrier. Pressure history in this pool indicates that negligible effect is felt from the underlying aquifer. Other thick oil columns, ranging from 240 to 600 ft, were found in the reef chain Bonnie Glen to Fiveland.

In addition to a large aquifer, several reservoirs have large gas caps. Therefore, highly favorable conditions are present for combined water and gas cap

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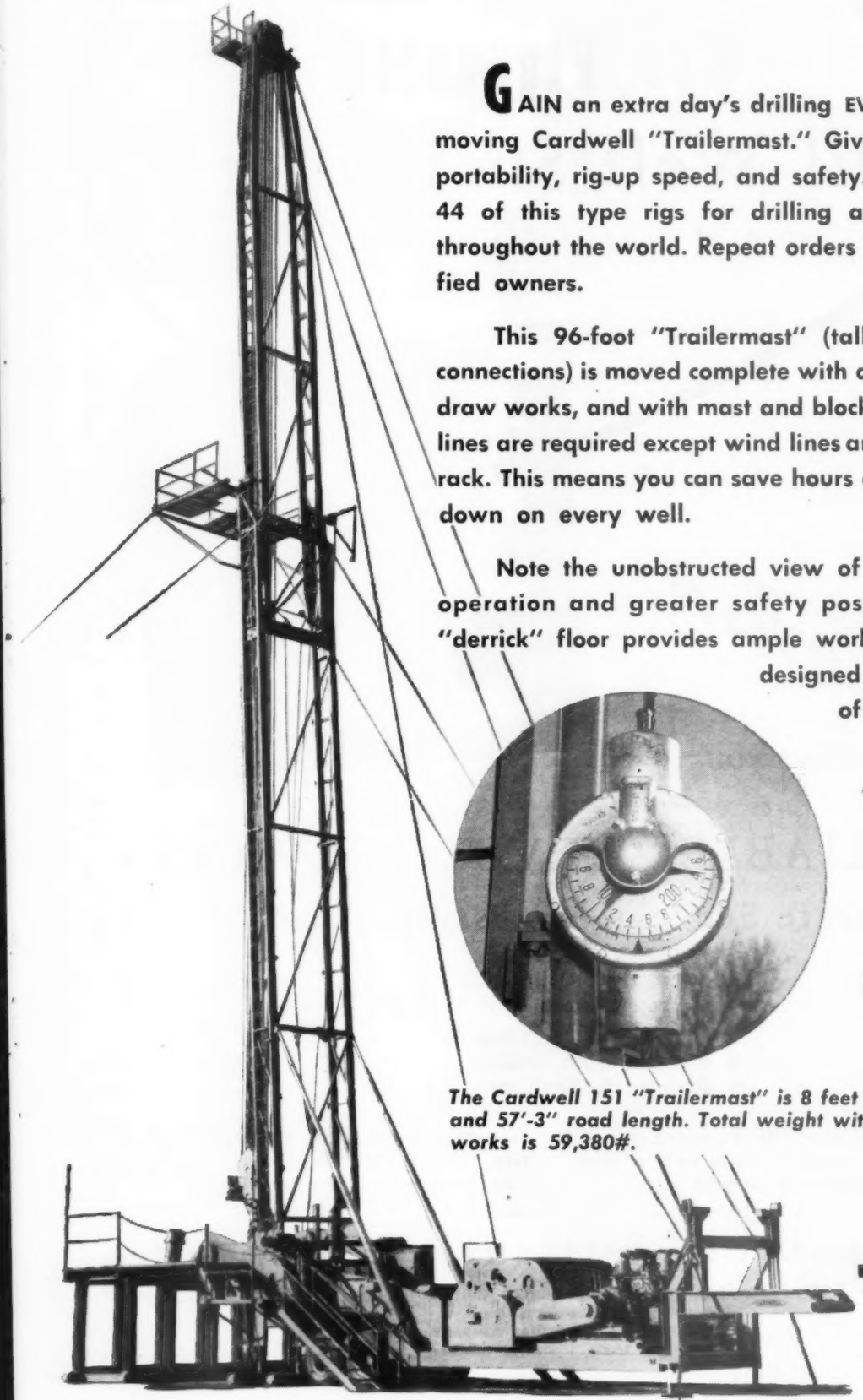

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drive, in some cases even assisted by gravity drainage. Although no estimator has yet been so bold to predict recoveries in excess of 50 per cent of the oil in place, it does not seem unlikely that this figure will be surpassed considerably if sound engineering practices are adhered to.

Conditions are considerably less favorable in the majority of the D2 reservoirs. Although water is encountered underlying the oil in this formation the benefit derived from it is rather limited. Stratification of the limestones and dolomites reduces the vertical movement of the fluids. The limited thickness of the D2 zone, averaging some 200 ft, together with the lateral porosity pinchouts, holds the aquifers down to a rather small size of which little expansion can be expected. Only in those strata where oil and water are virtually in direct contact can some waterdrive effect be expected as, indeed, has been observed in some cases. Where the D2 dips more steeply, water can move along a stratum and act as edge water. An exception to the foregoing is the Excelsior D2 pool. This reservoir trap is structural and was caused by differential compaction of the green shales over the underlying D3 bioherm. The mechanism of flood will be essentially a bottom water drive. Pressure versus production history indicates that some 200,000 bbl of stock tank oil were produced for one pound pressure drop. Replacement efficiency was calculated as 99.7 per cent. This pool has one of the most efficient waterdrives of the North American Continent.

Little effect is expected from gas cap drive and gravity drainage in the D2 reservoirs. Recoveries are usually estimated to range from 25 to 35 per cent.

Pressure Gradients

The Devonian reservoirs are encountered at depths ranging from 3100 ft to 6700 ft. Norman Wells tops the Devonian at between 1100 ft and 1950 ft. Redwater D3 zone is encountered at 3100 ft, and Bonnie Glen at some 6700 ft.

Reservoir pressures are lower than the hydrostatic head of salt water at the datum depths in all cases but one. In all Devonian reservoirs the pressure gradients fall in the margin of 32 to 38 lb per 100 ft depth, except Normandville in northwest Alberta, which showed a gradient of 46.5 lb per 100 ft depth.

Secondary Recovery and Pressure Maintenance

To date none of the Devonian reservoirs has been subjected to secondary recovery or pressure maintenance projects. It is only a little over five years since the first large oil reserves were found in the Devonian in the Central Plains. There has been no reason to start such a project in Leduc-Woodbend D3 zone because little pressure decline is noted. The D2 zone in that field should be looked into for gas or water flooding projects in suitable parts of the field. The next large discovery was Redwater. For some years now a pressure maintenance project has been studied. Pressures have declined from 1050 to just below 800 psig in four years. It is expected that a pressure of 600 psig will be reached in late 1953. This is only 115 psig above saturation pressure. Discussions and studies are being continued, but so far no other concrete steps have been taken than the installation of a salt water disposal system.

Golden Spike has shown a rapid pressure decline. Imperial Oil has made some preliminary studies with regard to pressure maintenance.

Many other Devonian pools are believed to be earmarked for some extraneous assistance. Many of these fields however, are recent discoveries and the productive limits are not known yet.

Another obstacle to the institution of secondary recovery or pressure maintenance projects is unitization of such pools. As is well known, not every lease holder and/or operator feels that he stands to gain by unitization. Unless the need becomes really pressing this issue may be carefully avoided.

Spacing

By order of the Petroleum and Natural Gas Conservation Board of Alberta the spacing pattern for Devonian reservoirs has been restricted to one well per forty acres. Imperial Oil has drilled the Golden Spike D3 reservoir on a 160-acre pattern, but does not get credit for draining more than 40 acres in the Board's proration method. ★ ★ ★

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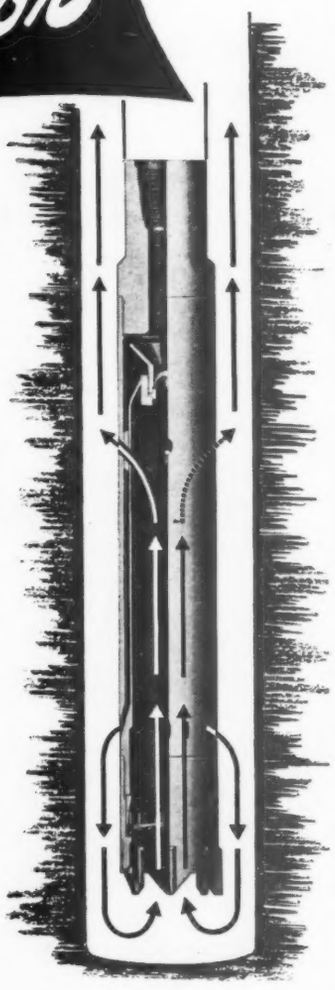

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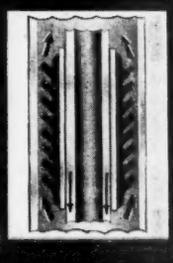

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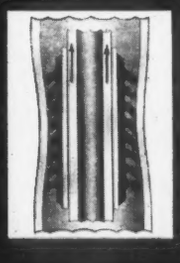

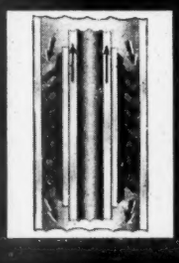

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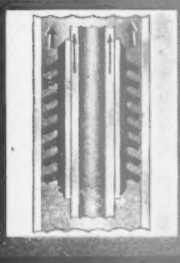

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Oil and Gas Conservation in the Province of Alberta—Aims and Accomplishments

GEORGE W. GOVIER

THE Petroleum and Natural Gas Conservation Board of the Province of Alberta was established by Act of the Provincial Legislature in 1938. At this time the Province's only oil field was the infant Turner Valley with an annual production of some 6,000,000 bbl. With expansion in the industry through the forties, and reflecting the increase in conservation knowledge in Alberta and elsewhere, the Oil and Gas Resources Conservation Act was variously amended to its present form being Chapter 46 (1950) and Chapter 47 (1951) of the Statutes of Alberta. This Act is the cornerstone of provincial administration of conservation in the oil and gas industry. Broadly, "The intent, purpose, and object" of the Act is—

"(a) to effect the conservation of the oil and gas resources of the Province;

(b) to prevent the waste thereof;

(c) to regulate the drilling, production and abandonment of wells and all other operations for the production of oil or gas, and

(d) to give each owner the opportunity of obtaining his just and equitable share of the production of any pool."

The Act provides for the appointment by the Legislative Cabinet of a three-man Board that "shall be a body politic and corporate." The Board has offices in Calgary and regional offices in Edmonton, Devon, Redwater, Turner Valley, Stettler, Camrose, and Lloydminster. With its staff of 100, 25 of whom are graduate engineers, the Board administers the Act and various regulations and orders issued under it.

The defining of conservation objectives and the attaining or partial effort spanning the past 14 years. The Government, the Conservation Board, and the industry in Alberta have leaned heavily on the experience and knowledge of industry and other government agencies elsewhere—particularly in the United States. Within the Province cooperation between Government, Board and industry has been of the highest order. The Conservation Act, and the drilling and production regulations issued under it, are quite literally the result of the joint efforts of industry and the administrative authorities. In the same way the conservation accomplishments of the Province are in a very real sense joint accomplishments of an enlightened cooperative industry and an understanding Board administering a realistic conservation program.

The Author

G. W. Govier has been a technical member of the Petroleum and Natural Gas Conservation Board of Canada since 1948. He has degrees from the University of British Columbia, University of Alberta, and University of Michigan. He has been employed with Standard Oil of British Columbia, Aluminum Company of Canada, and also engaged in miscellaneous consulting work. Since 1940, less 1½ terms on leave of absence, he has been an instructor, lecturer, assistant professor, associate professor, professor, and department head at the University of Alberta. He has done considerable research work most of which has been published.

The conservation objectives and the degree of their attainment may conveniently be highlighted and briefly discussed under the main topic headings of spacing and location of wells, drilling, testing and completion of wells, and production and disposition.

Spacing and Location of Wells

Objectives. The spacing and individual locating of wells so as best to provide, within the limitations of present day knowledge, for

(a) proper economic drainage, recovery and production of the underlying oil and gas; and

(b) protection of individual property rights through the prevention of lease line migration and adverse drainage.

Accomplishments. Considerable success has been achieved in establishing a sound pattern of spacing of wells within the province. The prescribing of normal spacing units, 40 acres for oil wells and 640 acres for gas wells, has resulted in the great majority of fields being developed on these standard patterns. Notwithstanding these normal spacing units, however, the Board "where in its opinion it is proper to do so, may prescribe a spacing unit of any size or shape or with any boundaries." Thus full consideration can be and is given to the unusual circumstances that may attend the development of long narrow structures, shallow fields with viscous crudes, and generally, fields where the normal spacing unit would be uneconomical or otherwise undesirable. The spacing unit regulations and the results of their use appear eminently satisfactory and the conservation objective may be said to be almost fully attained.

Within the spacing unit, regulations define a subsurface target area within which a well must be completed. In the case of the normal 40-acre spacing unit the regulations provide that:

"In order to qualify for a production allowable based upon the area of a legal subdivision or a forty acre spacing unit, an oil well shall be completed within a definite square target area, defined in accordance with the following rules:

(a) the center of the target area shall be in the vertical center line of the spacing unit, and the sides of the target area shall be parallel to the sides of the spacing unit;

(b) the side dimension of the square target area shall be a minimum of 330 ft and shall increase with depth at the rate of 0.04 ft per foot of depth to a maximum dimension equivalent to one-half the side dimension of the spacing unit; and

(c) up to this maximum value the side dimension of the target area shall be calculated in accordance with the following formula;

$$L = 330 + 0.04\,D,$$

Where

L = the side dimension of the square target area in feet, and

D = the depth of the well from the surface to the top of the producing zone in feet."

Such a provision, and comparable ones for other spacing units, insures the completion of wells within a readily and economically attainable distance from the center of the spacing unit, thus permitting relatively uniform underground drainage and minimizing lease line migration. Again, experience has shown the target area concept to be sound and to constitute a practical and close approximation to the theoretical ideal. The conservation objective may be considered fully reached.

Drilling, Testing, Completion

Objectives. (a) The conduct of drilling operations in a safe and mechanically efficient manner with proper care being taken to minimize surface damage, to prevent injury to reserves of other min-

EXCLUSIVE

erals, and to prevent the uncontrolled escape or migration of underground fluids, whether oil, gas or water.

(b) The adequate testing of wells by drill stem test, production test, electro and other logging techniques, and the taking of fluid samples, rock cuttings and proper cores to the end that the maximum economically justifiable amount of information will be obtained with respect to the location, quantity and nature of the subsurface oil, gas and water.

(c) The completion of wells in a manner to prevent the escape or migration of fluids from other strata; to permit the safe recovery and controlled production, with efficient use of reservoir energy, of oil and gas; and to permit complete well testing, the measurement of surface pressures and temperatures and the obtaining of subsurface samples.

Accomplishments. The degree of success of the provincial conservation program in drilling, testing, and competion operations is closely related to the technical advances made by the industry. New equipment and new methods have joined with experience to bring a close realization of the main objectives.

Directional drilling under lakes and rivers and the complete casing and cementing off of subsurface fresh waters has given almost complete protection to the supplies of fresh water. The vastness of Alberta's coal resources made drilling for oil and gas through commercial coal deposits inevitable. New casing and cementing practices have permitted the simultaneous, safe, and economic development of both these minerals.

Extensive test data on wells, reservoir characteristics, and fluid properties are obtained both by the industry and the Board. The Board conducts frequent bottom hole pressure surveys, with bomb and echometer, of all important producing areas. Oil, gas, and water samples obtained by the Board staff or submitted by industry are analyzed through cooperation with the University of Alberta. Operators are required to submit copies of all tests, logs, and analyses. Thus unusually complete records of drill stem tests, electrologs, radio activity logs, pressure and temperature measurements, and core and fluid analyses are maintained. These records, and complete production statistics, are available to the industry and serve both the Board and industry well in determining improved drilling and production practices.

Completion techniques are in most cases representative of best current practice. Some difficulties have been encountered with poor cement jobs and improvements are being sought. Gas shut-off in thin pays is also not always satisfactory. Some of the newer thin pay completion techniques have yet to be tried in Alberta. All in all, however, the record is satisfactory.

Production and Disposition

Objectives.

(a) Production of oil only for effective utilization, based upon a full understanding of the reservoir situation, in accordance with sound engineering and economic principles and at rates which are "optimum" having record both to the engineering and economic factors and to the principles of equity.

(b) Production of gas in association with oil to be only for effective utilization and to be kept to the practical and economic minimum so as to preserve reservoir energy and drainage efficiency in the interests of greater economic recovery of oil. Unavoidable production of gas in excess of that capable of effective utilization to be reinjected, if economically possible, to the same or another formation and conserved for future use.

(c) Production of gas from reservoirs not containing oil to be only for effective utilization, in accordance with sound engineering and economic principles and at rates which are "optimum" having regard both to the engineering and economic factors and to the principles of equity.

(d) Production of underground water associated with either oil or gas to be kept to the practical and economic minimum so as to preserve reservoir energy and drainage efficiency in the interest of greater economic recovery of oil and gas.

(e) Following a full understanding of the natural reservoir situation, the earliest possible implementation of necessary or economically desirable auxilliary ("secondary recovery") measures to aid in the greater recovery of oil or gas.

Accomplishments. Substantial strides have been made, in Alberta as elsewhere, in the application of the concepts of conservation to methods and rates of production of oil and gas. Much remains to be done but this need not detract from present accomplishments.

In the field of regulation of oil production the Province of Alberta has been especially fortunate in being able to take advantage of the experience of others, whose "Leduc's and Redwater's" were discovered earlier. In early 1950, when the productive capacity of the Province was still less than the available market, the Board systematized its approach to the problem of determining allowable rates of production of oil wells. The so-called "MPR formula" was introduced to permit, early in the life of a field, a consistent and realistic estimate of the Maximum Permissible Rate of oil production having regard to the engineering factors involved. This formula and its methods of application have been discussed elsewhere.[1,2] Briefly it may be stated as —

$$MPR = T\ F_A\ F_{PS}\ F_D\ F_{RL} \text{ barrels per well per day}$$

Where

T = thickness of pay, ft

$F_A = \frac{1}{40}$ area of spacing unit, acres

$$F_{PS} = \frac{(\text{porosity*})}{(.10)} \frac{(\text{1-connate water*})}{(.75)} \frac{(\text{shrinkage factor*})}{(.75)}$$

F_D = reciprocal measure of degree of pool development, not to exceed 2.5

F_{RL} = recovery-life factor

$$= \frac{50\ (\text{estimated recovery*})}{\text{estimated years of life}}$$

*as fractions.

The formula is not perfect. In reality it is nothing but a volumetric reserve estimate reduced to a daily rate. It has proved extremely satisfactory, however, in providing a "handrail to judgment" early in the life of a pool when the true "MER" is quite undefinable.

Later, when Alberta's productive capacity grew to exceed its currently available market, equity considerations necessitated the Board's introduction of a further scheme — proration to market demand. This scheme does not do away with the MPR concept — it is in fact founded on it. The proration plan, also described elsewhere[2,3], provides that each well in the province, to the limit of its ability but not to exceed its MPR, shall share in the available market: (a) by receiving a basic "economic allowance" (scaled on the well depth taken as the single most significant parameter of economic need) and (b) by receiving a share of any remaining market based upon the ratio of its MPR to the provincial total MPR. Thus the MPR becomes, in the proration plan, the basis of sharing the portion of the overall market in excess of that required to pay each well a "living wage."

From the viewpoint of meeting its conservation objectives related to oil production Alberta can report good progress. The present system works well, the danger of reservoir damage is light, and individual equities are well protected. The objective is perhaps 90 per cent attained.

In the matter of gas production from oil fields, the situation is not quite so favorable. Individual well gas production is subject to limiting gas-oil ratio control and penalties are introduced, generally, for ratios in excess of 1000 cu ft per barrel. Unfortunately, however, all the produced gas does not find effective utilization. In Turner Valley and Leduc gas is gathered, processed and utilized. Elsewhere such casinghead gas is at present mostly flared. The following table[4] is indicative of the current situation:

Casinghead gas disposition Province of Alberta, August, 1952.

	Leduc Woodbend		Turner Valley		Other Oil Fields*		Total Oil Fields	
	MMCF	%	MMCF	%	MMCF	%	MMCF	%
Production	1050	100.0	2108	100.0	923	100.0	4081	100.0
Lease fuel	38	3.6	90	4.3	22	2.4	150	3.7
Field waste	378	36.0	194	9.2	901	97.6	1473	36.1
Gathered	634	60.4	1824	86.5	nil	0	2458	60.2

* Figures approximate.

Canada

True enough in many instances the economics of gathering, processing, and marketing, or storing are not attractive — in some cases downright unattractive! Much remains to be done, however. Industry incentive and Board pressure are bringing changes and systems aggregating over 40,000,000 cu ft per day are currently in the serious planning stage. If 80 per cent utilization of such unavoidably produced gas is taken as a reasonable and economic objective, Alberta is now three-quarters of the way to its goal. The next two years should see the gap further closed.

Gas production from gas and condensate wells poses several unsolved problems. Alberta is still far from arriving at a really satisfactory plan for setting "MPR's" — production allowables based on engineering factors. The old "20-25 per cent of open flow" rule of thumb still finds application with scant sound engineering backing. Proration to market demand is a problem that has not yet been encountered with gas — but it will be. The concepts of the oil proration plan will no doubt serve usefully when this occurs. It is difficult to assess the degree of accomplishment of the conservation objective here — perhaps 75 per cent.

Salt water production and disposition Province of Alberta, August, 1952. (Quantities in barrels)

	Joseph Lake	Leduc Woodbend	Lloyd-Minster	Redwater	Other Fields and areas	Total
Production	14,063	24,915	21,585	132,247	74 370	267,180
Water disposal systems	14,066	4,269	—	65,937	—	84,272
Other	−3	20,646	21,585	66,310	74,370	182,908

The question of water production and its proper disposition is one of growing importance in Alberta. Production volumes are restricted through penalties based upon water-oil ratio. Little can be done, however, to halt the trend to higher ratios and greater volumes as water drive fields mature. Reinjection schemes that return produced water to the formation are underway at Joseph Lake and Golden Spike, and beginning at Redwater. Elsewhere water is disposed of by evaporation and seepage from surface pits — in most cases harmlessly enough. A scheme for Leduc is in the planning stage. Recent statistics[4] indicate the current situation given in the table above.

Although it will never be economical or even desirable to reinject all produced water through water disposal systems, Alberta still must travel a long road before fully reaching its conservation objectives.

It seems appropriate to conclude this appraisal with a reference to "secondary recovery" activities. In general, the industry, through individual companies and pool committees, has taken an active interest in reservoir studies and planning for greater ultimate recoveries. A company sponsored "pilot water flood" has been underway for several years in the Turner Valley field. Here the reservoir rock is a tight low porosity limestone and field tests provide the only way of evaluating the possibilities of secondary recovery. Other pools in the province, although all relatively young, are receiving serious study by individual companies, pool committees and the Board. A gas pressure maintenance scheme is being initiated at Golden Spike, a water injection project is being studied for Redwater and the Leduc D2 pool is not escaping attention. It is more than likely that the next two or three years will see artificial pressure maintenance and other programs under way in many of the fields that were only discovered four years ago or less.

This healthy interest, not only in utilizing nature's reservoir energy to its economic fullest, but also in supplementing these natural forces is an excellent barometer of the overall conservation accomplishments. Measured this way there can be no doubt of Alberta's progress in the past 14 years.

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3. Millard, V., Address before Interstate Oil Compact Commission, Banff Meeting, September, 1952.
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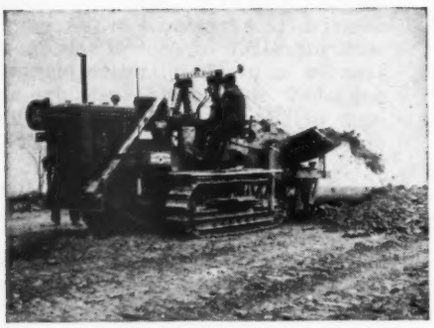

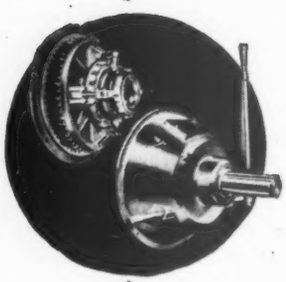

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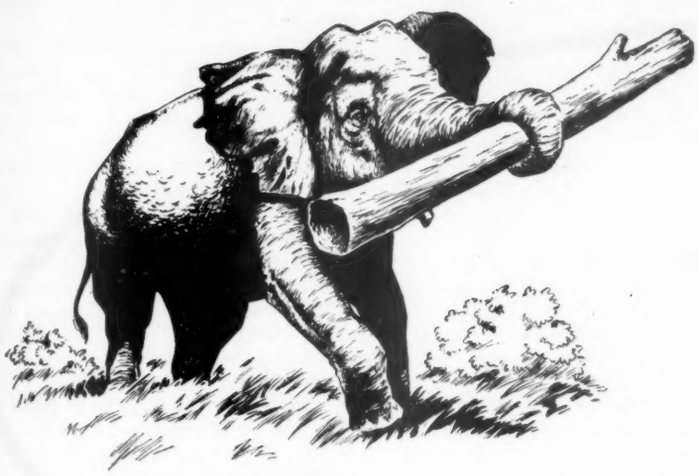

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Gas Lift As It Applies to Deep Production

Operators, who desire to produce economically, find wells below 8000 ft often present many problems from a mechanical standpoint

CARLOS R. CANALIZO*

In the last few years, with the advent of deep well drilling, a new secondary production problem has arisen. Declining bottom hole pressures and increasing water encroachment are two factors that are causing fluid levels to drop. Lifting wells from depths below 8000 ft has made the costs an important consideration in most cases.

Many deep wells are angled to by-pass junk that has been lost, or directionally drilled to locate an oil reservoir. Under these conditions any lifting methods involving parts moving within the pipe strings is problematical, and the resulting wear may require expensive rig operations to change worn equipment. With gas lift, however, there are no moving parts within the pipe strings, and with the new gas lift equipment now available, it is possbile to change gas lift valves with an inexpensive wire line unit.

*Sales Engineer Camco Inc.

Gas lifting wells below 10,000 ft is now commonplace. New gas lift valves are manufactured to withstand pressures in excess of 5000 psi. They are constructed of the finest non-corrosive materials. with the hardest materials available used at the points where abrasion and gas blast occur. Large port valves permit lifting deeper and more efficiently with lower gas pressures, and take advantage of large gas volumes instead of high pressures.

The new type gas lift valves may be described as unbalanced back-pressure valves. They are specifically designed for use in extremely deep wells, of normal to low volume characteristics. The operation of the valves is controlled at the surface by a simple time cycle controller, which intermittently injects gas into the well at predetermined cycles.

The gas lift valve is so designed that the fluid head in the tubing above the operating valve is partially effective, along with the built-up gas pressure in opening the valve. The port area of the valve ranges from 5/16- to 5/8-in. diameter, and for all practical purposes is completely controlled by the casing pressure. This large port permits a quick entrance of gas volume in a short period of time. This action in the well immediately places a piston-like pressure under the hydrostatic fluid head, lifting it to the surface with little slippage. This, in gas lift terms, is called "slug" lifting.

A fairly recent intermitter installation in the West Texas Pegasus field is producing 60 bbl of fluid, 25 per cent water from an operating depth of 12,900 ft. The maximum capacity of the well is 60 bbl. The well is being lifted with a surface supply pressure of 600 lb. This well was completed in the Ellenberger zone, and has a high bottom hole pressure, but a very low productivity index.

In Louisiana, in the Pointe-a-la-Hache area, there are many installations of intermittent lift, operating below 9000 ft.

An example of a typical deep well gas lift installation is in a Devonian well in the Shaffer Lake region of Andrews County, West Texas. The well had never flowed naturally, and the operator wanted to test it. The total depth was 11,099 ft, bottom hole pressure 643 psi, static fluid level 9518 ft from the surface, casing size and weight, 5½ in., 17 lb and tubing 2-in. EUE. Supply gas is furnished at 900 psi with ample volume. The valves are installed at the following pressures and depths: 875 psi at 9594 ft; 875 psi at 10,142 ft, 875 psi at 10,624 ft; and 800 psi at 10,935 ft. The well has a packer set at 10,988 ft which makes this a closed system. At last report the well was producing 106 bbl of fluid with an input gas-fluid ratio of 1290 cu ft per barrel.

In Lea County, New Mexico, an oil company has several wells that produce from the McKee sands formation at approximately 9400 ft. These wells are all on intermitting lift, producing from the bottom valve which is pressured at 600 lb and installed approximately 100 ft off bottom. Individual well production figures range from 48 to 215 bbl of fluid per day, and the input ratios range from 660 to 1215 cu ft of gas per barrel of fluid.

Factors

In deep well lift, there are many factors that should be considered. It is necessary to know the well conditions in order to provide an efficient gas lift installation. The majority of deep lift wells are low productivity wells with either (1) a low productivity index, low bottom hole pressure, or (2) a low productivity index, high bottom hole pressure. In the former, it is usually a simple installation as the fluid level, even under static conditions, remains low. In the latter, with the well under static conditions, the resulting high fluid level would require an installation that would unload the well down to the working fluid level.

It is necessary to know the following factors in calculating the installation:

1. Productivity
2. Bottom hole pressure
3. Desired fluid production
4. Static gradient of fluid to be lifted
5. Available gas pressure
6. Trap pressure at well
7. Geothermal gradient

Where it is necessary to maintain all the available surface pressure in order to have sufficient gas pressure to lift a deep well, the new fluid-operated valves permit unloading the well down to the working fluid level. At this point, large port intermitting valves are installed, permitting the well to be lifted efficiently by a surface time cycle controller.

Gas lift installations have proved that it is economically feasible to lift fluid from deep wells. * * *

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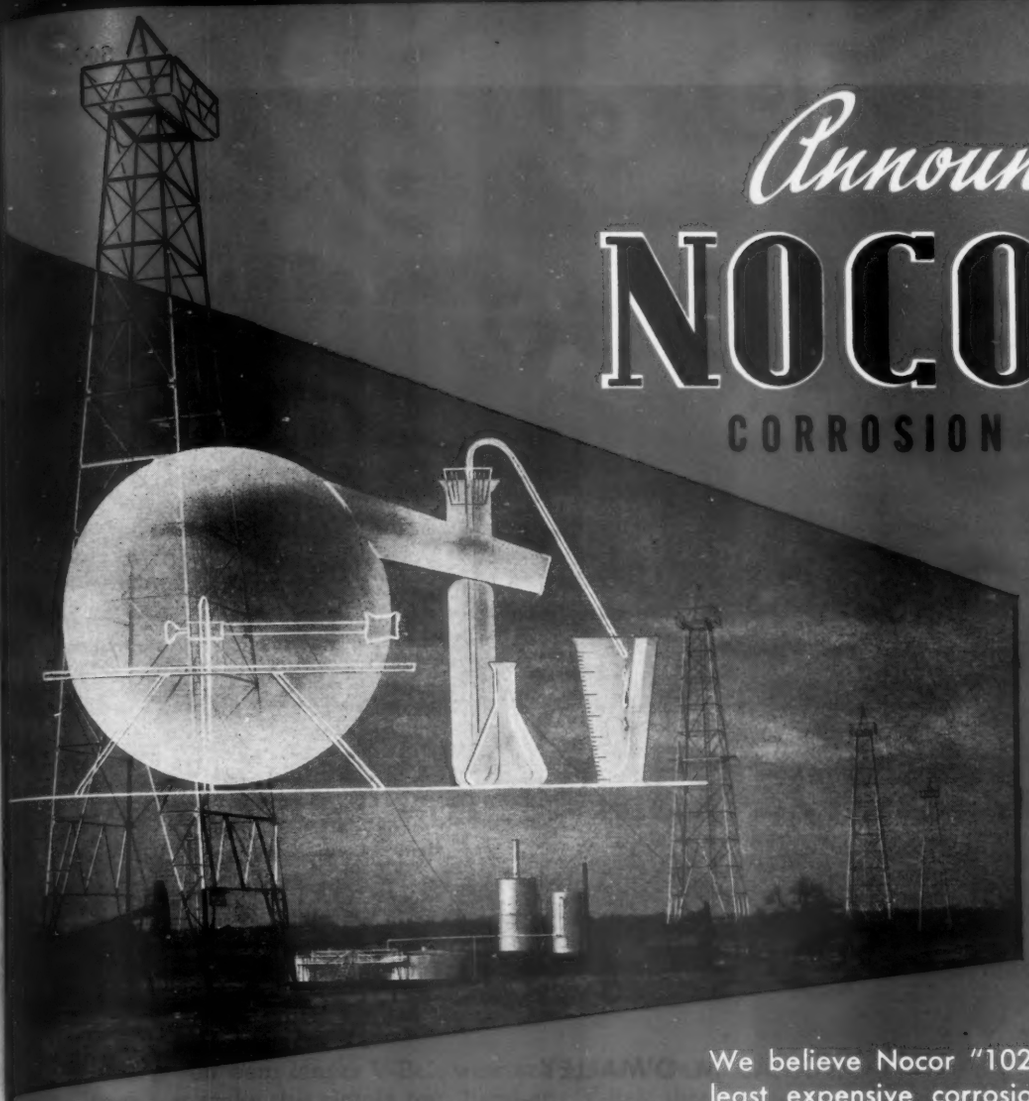

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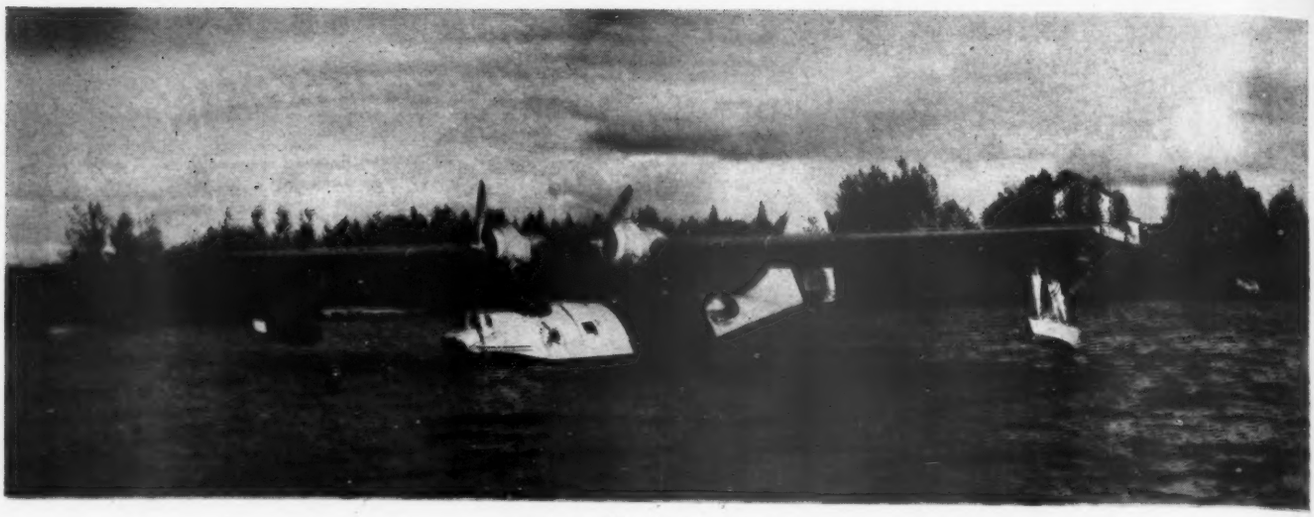

With the Canso, lake-based surveys can be carried out in remote areas, far from airport facilities. The big plane was used extensively in the Northwestern surveys.

Air Surveys Speed Canadian Exploration

Five joint studies with airborne magnetometer will cover over 100,000 square miles in the Northwest

THOMAS M. O'MALLEY

More than 100,000 square miles of the Canadian Northwest are now being explored with the airborne magnetometer. Nine major oil companies are underwriting five air surveys this year, ranging in size from a few hundred square miles to a broad reconnaissance study of more than 48,000 square miles. Four of the surveys are being executed by Canadian Aero Service, Ltd., and one by another company.

Unlike the 16,000,000-acre Peace River survey in 1950-51, which was a broad, general study with four participating companies and the door wide open for more, the current surveys are of a much more closed nature. In itself this may very well indicate that favorable results were found in the initial surveys.

Although the new survey areas and contracting companies cannot be named, it may be said without any breach of security that large areas in the Northwest Territories, Saskatchewan, British Columbia, and Manitoba are being explored. Two types of areas are being studied from the air:

1. Exploration over leases and reservations.

2. Exploration in new areas, as a preliminary to a reservation play.

Large portions of the surveys are being flown over muskeg — difficult terrain to traverse on the ground in winter or summer. The airborne magnetometer is again being employed for rapid, low-cost reconnaissance of big areas, to help guide the necessarily slower and more costly ground studies. It is expected that the aeromagnetic data may be interpreted to provide useful geologic data of a general character — regional trends, some indications of basement structures, and other reconnaissance data for areas never before examined.

The four major airborne magnetometer surveys being executed by Canadian Aero Service are being flown by four aircraft — three Ansons and a Canso amphibian. Aircraft and flight crews are being provided by Spartan Air Services, Ltd., Ottawa, with whom Canadian Aero Service is affiilated. The Gulf high sensitivity magnetometer, which registers variations in magnetic intensity as small as 1 gamma, is the survey instrument. The plane's path is recorded with a continuous strip camera, so that its position throughout the survey can be reconstructed exactly when the magnetic maps are compiled. The traverse line separation varies from one mile to three miles, depending on the expected depth to basement and the analytical procedures to be employed in using the survey data.

Photo flight-maps guide the survey planes, and for the most part the photography was purchased from the Dominion Government. If no photos

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The Author

Thomas M. O'Malley, president of Canadian Aero Service, Ltd., has a broad background of 17 years home office and field experience in aerial mapping and exploration. As a project engineer he has directed extensive photographic and magnetic surveys in Africa, the United States and Canada. At the home office he has headed a large staff engaged in the compilation of magnetic and topographic maps. Since 1950 O'Malley's organization has mapped well over 200,000 miles in Canada with the Gulf airborne magnetometer.

Before coming to Canada, O'Malley was associated with Aero Service Corporation, Philadelphia. During the war he served as civilian consultant on photo mapping for the U. S. War Department, on special assignment at Kew Gardens, Surrey, England, and later saw military service with the 91st Division in Italy.

O'Malley was connected with the early, pioneering applications of the airborne magnetometer to commercial surveys, and he has been responsible for some important data compilation and control techniques.

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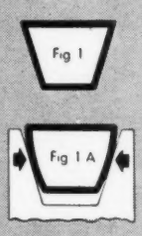
What Happens When a V-Belt Bends

Straight-Sided V-Belt



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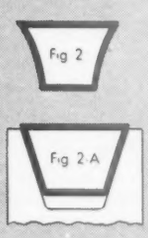

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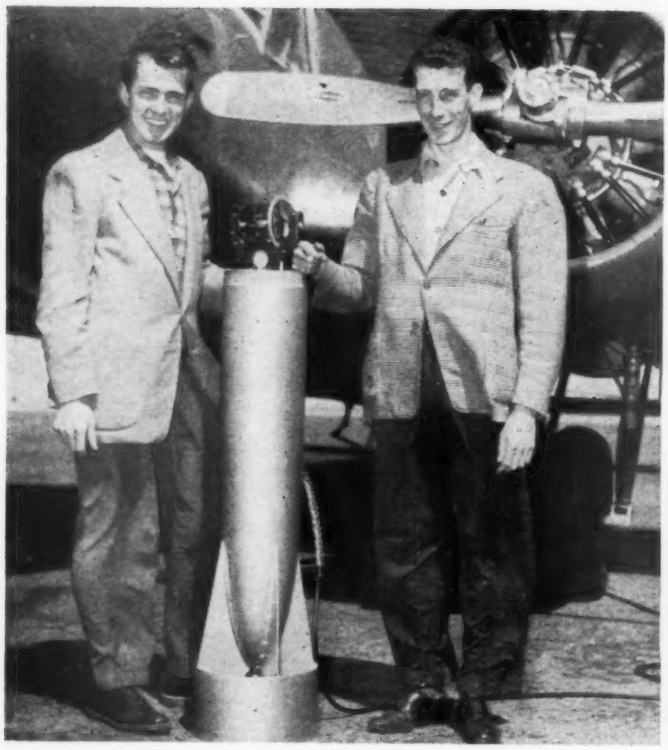


Two crew members make a pre-flight check of the Gulf airborne magnetometer. The survey plane, an Anson, is seen in the background.

Flight personnel and ground magnetometer operator synchronize their watches according to radio time signals, so that the records of airborne magnetometer and the monitoring unit can be correlated.

The high sensitivity Gulf magnetometer, which records magnetic variations as small as 1 gamma, surveys over typical brush country.

Identifiable points are more numerous in this area than in many flown during the survey.

exist, or if available photography is at the wrong scale, the magnetic study is preceded by photo-mapping by Spartan Air Services crews. In any case, a radial plot is prepared so position or scale errors of the individual photos are corrected and the magnetic data plotted to a proper map base. Government made topographic maps or controlled photo-mosaics exist for some of the survey areas.

Flying of the surveys began late last spring, soon after the survey contracts were signed. The surveys are slated to go on through the winter; snow and cold weather make no difference in the magnetic record, though routine winter flight operations in these Provinces is no picnic.

In large surveys over remote areas, there are always certain supply and transport problems. An ample number of spare parts for the aircraft and geophysical instruments must be at hand, for replacements come slowly when you're 2500 miles from home base. In a number of areas in the Northwest aviation gas is not available in the quantities required, and special arrangements were necessary. In one case, several thousand gallons were flown to Providence from Yellow Knife, using a Ventura based there as part of a 35-man

Shoran guided photo operation that was being carried out in the Northwest Territories.

Then there are the unforeseeable problems. For example, early in the Spring two planes were hung up for a time at an advanced operations base along the Mackenzie Highway in northern Alberta. The landing strip here was turf, and in dry weather it was a good field. It was used happily for several days. Then it rained — long and hard. The strip was a bog, and the crews were mud-bound for a few days.

Weather Is Headache

Weather is the air mapper's great headache, of course. In the early part of the season one may be able to fly 15 days or so per month. During the latter part of the year, because of atmospheric and/or magnetic storms, the flight days may drop to an avergae of 3 to 5 days per month. With the Ansons two flights of 3 to 5 hours each were flown daily (weather permitting) and covered about 800 miles when the survey area was reasonably close to the operations base. With the Canso amphibian about the same number of miles was mapped in one daily flight of 7 to 9 hours duration, thanks to this plane's quite large fuel capacity.

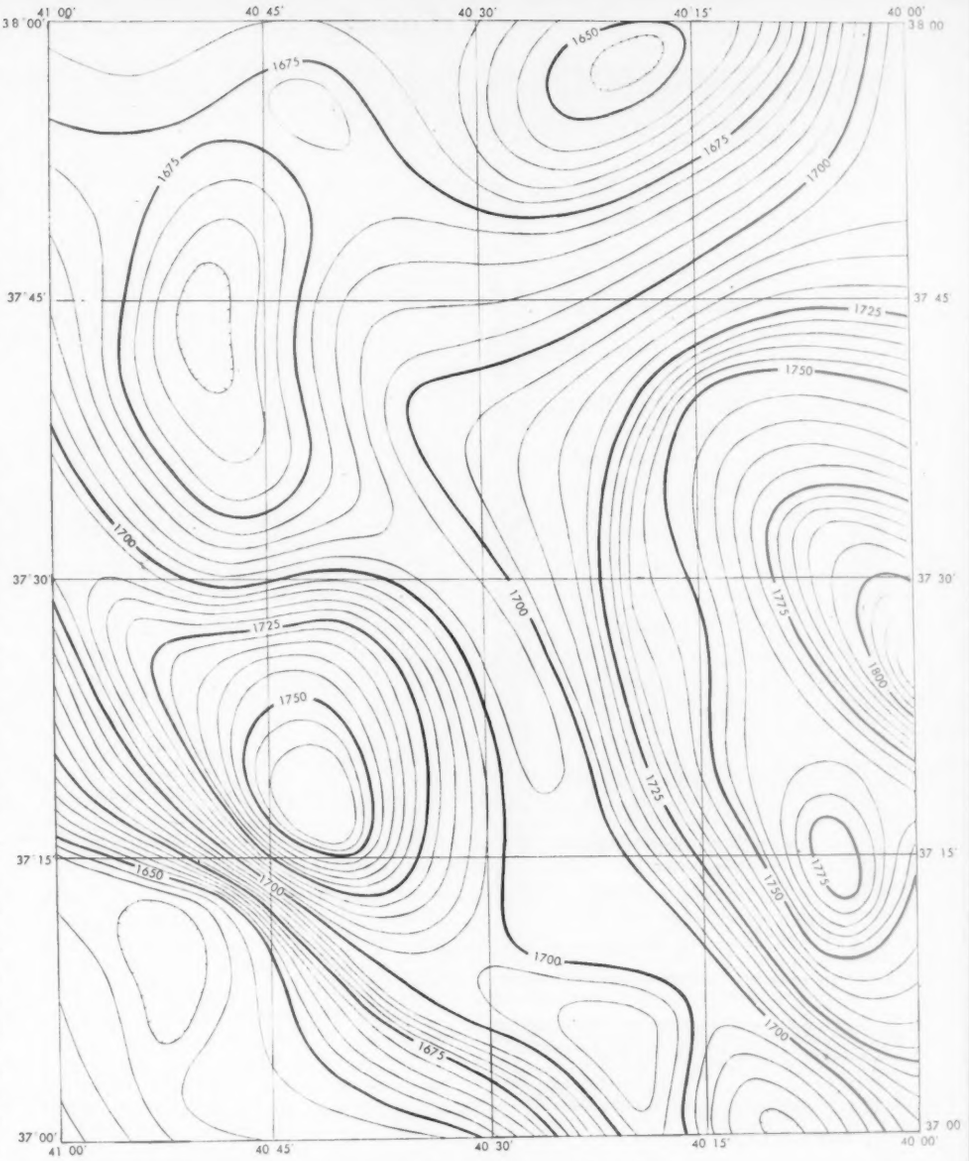
A great part of this Northwest country is difficult to map because so much of it is muskeg, with few distinguishing features. To fly a straight line within close tolerances at 150 mph the survey pilot looks for readily identifiable points on the ground — roads, streams, section lines, farm houses, a clump of trees, and so on. But there are few such "identities" in muskeg country, and the pilot must be a skilled and experienced airman to stay on course. He depends on earth colors to see distinct areas too, which is the reason a pilot is apt to be cranky as a bear in the Fall, for instance, when all the earth colors become an almost uniform brown. On the other hand, snow covered over cultured areas — fences, roads and houses — makes it easy to find identities, but snow is no help in the bush flying.

Each plane's crew consists of a pilot, photographer-copilot, and magnetometer operator. The amphibian, however, carries a relief pilot and flight engineer because its greater fuel capacity permits quite extended flights, requiring relief personnel.

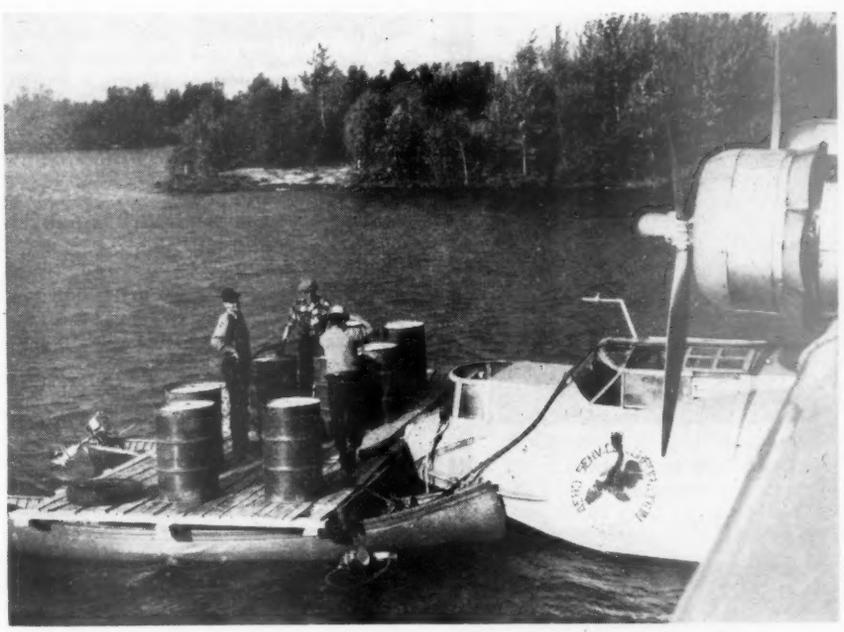
Northwestern activities are headed, finally, by a project manager who directs the activities of the several survey groups. He was a key man in the Peace River work, and for several years before joining the staff was identified with the magnetic work of the Canadian Department of Mines and Resources, as their chief electronic engineer.

In addition to the flight personnel, an electronic engineer mans a ground monitoring station, a Gulf magnetometer identical with the survey instruments, on the alert for magnetic storms. Radio communication is maintained with all flight crews, so that flights can be cancelled or recalled in case of any significant magnetic disturbance.

Here the Canadian Department of



Representative magnetic map, typical of the configurations from an oil survey. Some maps are compiled at a 5 gamma contour interval but most oil survey data are contoured at a 10 gamma interval.



Refueling the Canso from an improvised canoe-raft. The big amphibian flew 7 to 9 hours daily during the Northwestern surveys.

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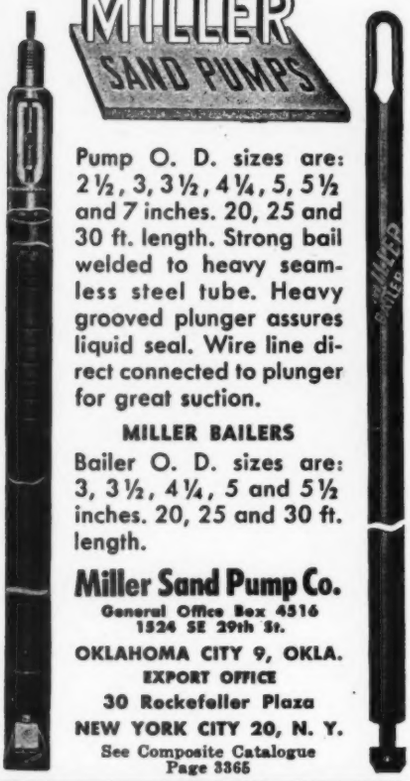

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Through-the-winter operations mean that you cover up the engine cowlings overnight, then use auxiliary heaters in the morning to bring the engines up to operating temperatures. This is one of three Ansons used in the mapping of more than 100,000 miles in the Northwest.

Transport and the Royal Canadian Corps of Signals were a great aid. Information was provided about diurnal variations to their nearest station, and every hour they made a brief code announcement of the prevailing diurnal condition. This came at the end of their meteorological broadcast, and all the flight crews were tuned in for this vital operating information. If the announcement was "Diurnal mountain," they knew magnetic storms were raging with no prospect of early clearing. "Diurnal foothills" signified magnetic activity too great for survey flights, but told the flight crews to stand by for a report an hour later. "Diurnal prairie" indicated conditions nearly operational, and "lake" and "sky" represented good and excellent survey conditions respectively.

In the field with the survey crews is a small data staff. They inspect and process the raw data and work closely with oil company geologists. During some surveys the customers come to the advance base. There are a number of advantages for the client in such close liaison with the survey group. The geologist can study the raw data from day to day, directing additional, closer interval flights over areas of particular interest to detail further the magnetic information for the area. If he wishes, the geologist may join in as an observer on the survey flights, for a firsthand view of the terrain from an altitude of 1000 ft. Incidentally, game has been known to wander within gunshot and the fishing often is unbelievable at some of the advance camps.

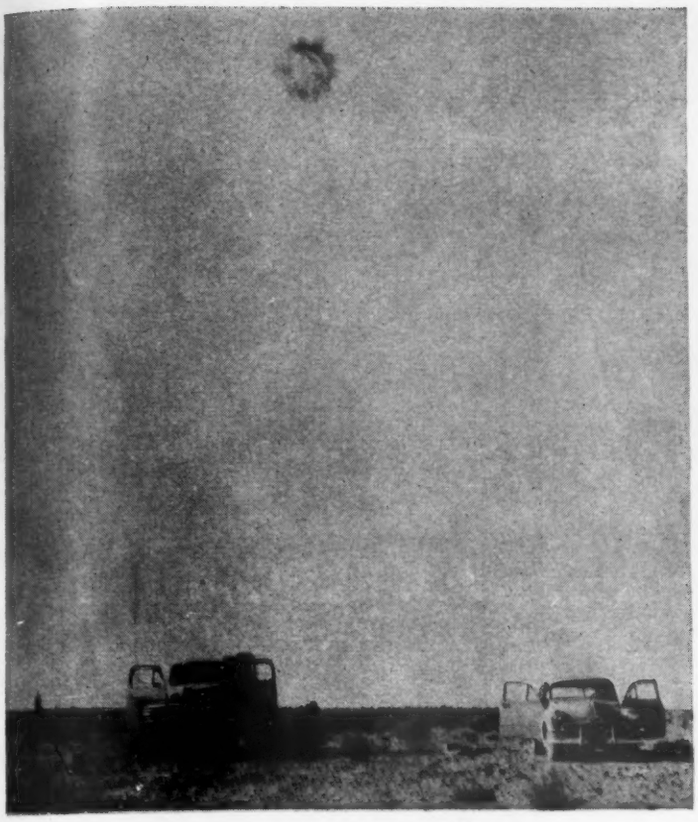
The field crews air-ship the survey data to the main offices in Ottawa, where it is compiled in magnetic intensity maps. Most of the maps are compiled at a 10 gamma contour interval, usually with a horizontal scale of 1 inch equals 1 mile. Preliminary contour sheets are the first delivery to the client. These differ from the final maps only in general appearance or finish. They are penciled sheets, accurate in all details, which can be completed quite rapidly by the compilation staff for the geologist or geophysicist, who is usually anxious to have the maps as quickly as possible. Later the final, inked map sheets are delivered to the client, along with the magnetometer survey tapes.

Joint Surveys

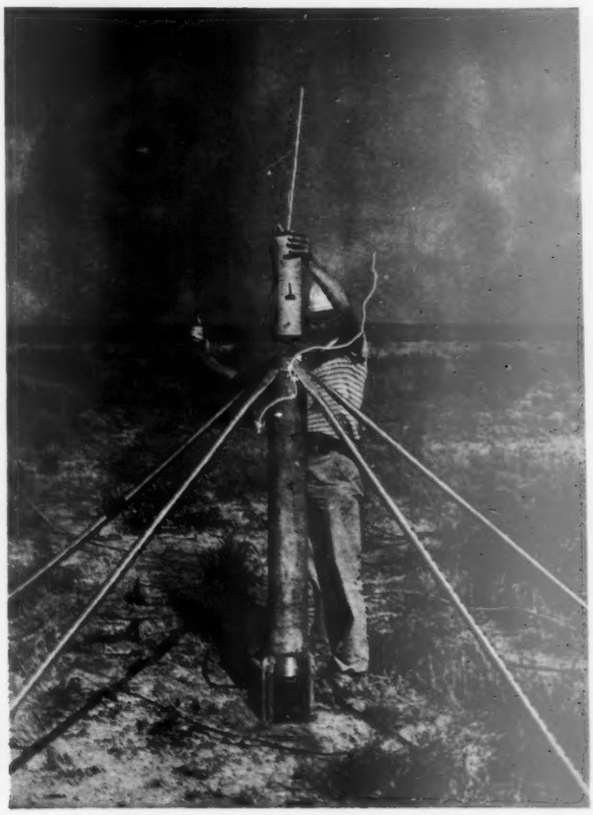
In the case of joint surveys, there is an agreement among participants concerning the priority of various survey areas. As survey blocs are completed, the map sheets are delivered simultaneously to all participants. Copies of all the magnetometer survey tapes for each company are available for the cost of reproduction. Cooperative surveys, now usually done for two companies, are common. It is felt by most geologists and geophysicists that the significance of the magnetic data is considerably increased as the size of the continuously surveyed area is increased; hence the shared reconnaissance.

Today it appears that 1 to 2 per cent of the $100,000,000 oil exploration budget in Canada in 1952 is going into air surveys. Though small in dollar volume, the air reconnaissance has large importance in the areas covered and the direction given to the ground studies, which are many times more expensive in terms of unit area.

At the present pace, it is conceivable that within a few years the whole possible petroleum area will have been explored from the air. And this vast work will have been performed in spite of problems of logistics and of terrain difficulties and of the magnetic storms. The potentialities and special utility of the airborne magnetometer is ideally suited to the Canadian exploration environment, and it appears likely that the airborne magnetometer will continue to see wide use by oil companies as a "first tool" in their exploration programs.* *



Aerial shooting party in the field with shot exploding at a predetermined height. Note absence of drilling truck, shooting truck and water truck.



Closeup of bomb being placed in mortar. The Archimedan spiral that controls explosion height can be seen. Firing squib and propellant are already in lower end of mortar.

New Aerial Shooting Technique Faster

Entire process is a development of real consequence to both the oil finding scientist and the petroleum industry at large

CONSIDERABLE interest was excited at the annual meeting of the Pacific Section of the Society of Exploration Geophysicists in Los Angeles recently by Dr. J. J. Jakosky's* disclosure of an aerial shooting technique in which a mortar is employed to project a high-velocity explosion to any predetermined height, between 50 and 600 ft. The method was subjected to investigation and test for three years in both field and laboratory before being turned to commercial use.

Particularly attractive features of the procedure are that it at once eliminates the need for expensive drilling equipment, shooting trucks, and water trucks, and subsequently by cutting drilling time, increases the crew output, and reduces survey cost. It is estimated that under normal conditions of terrain, an aerial shooting crew can cover from 2½ to 3 miles a day of traverse line, when it is using 1320 or 1760-ft split-spreads.

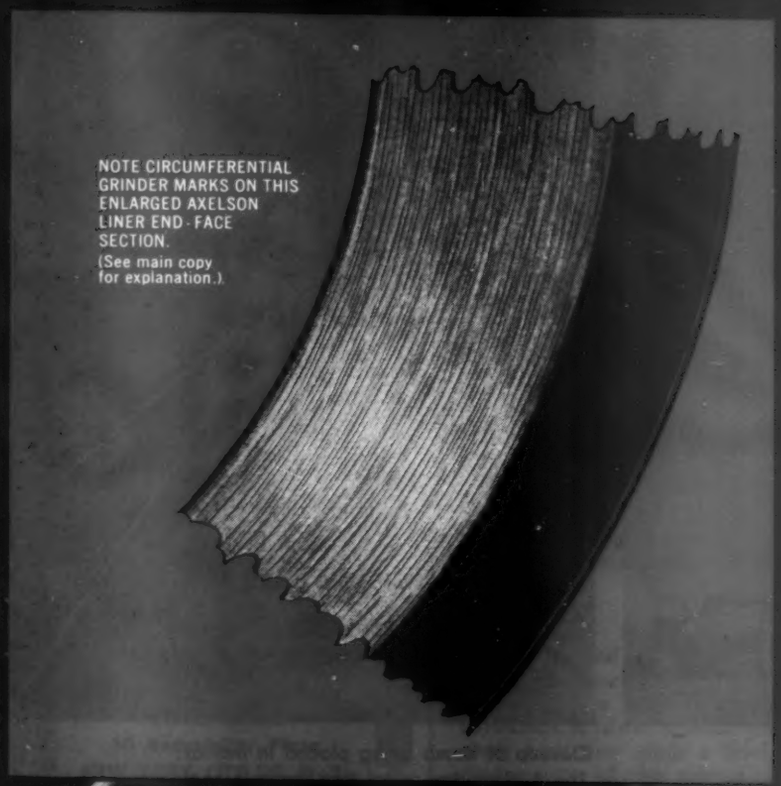
Dr. Jakosky pointed out that aerial shooting is no new idea. In this connection he cited the work of Burton McCollum who suggested kites, balloons, or airplanes to elevate the explosion to a height at least as great as the depth of the reflecting stratum and preferably several times that high; and Dr. T. C. Poulter whose method has been widely publicized—it utilizes a pattern of charges that are exploded at 8 to 15 ft above the ground.

The Jakosky procedure, on which patents are pending in the U. S. and foreign countries, neutralizes much of the detrimental effect of ground roll and other interference normally encountered in aerial shooting, by controlling the height of the explosion between the two extremes already mentioned, i.e., 50 to 600 ft. There is then an upper and lower limit within these extremes between which, for each type of area, the optimum reflection interference ratio may be obtained.

Investigation of various means of elevating the charge to the proper altitude finally resulted in the choice of the mortar method which, for seismic work, offered a number of important advantages, both operational and economical. Control of the explosion height was also the subject of much study. It was found for example, that inequities in time-delay caps precluded their use and that variations in muzzle velocity were responsible for errors of intolerable dimension so that any species of time control had to be ruled out, and the procedure later described was adopted.

It should be explained first, perhaps, that the bomb that carries the explosive

*President of International Geophysics, Inc., and author of "Exploration Geophysics."



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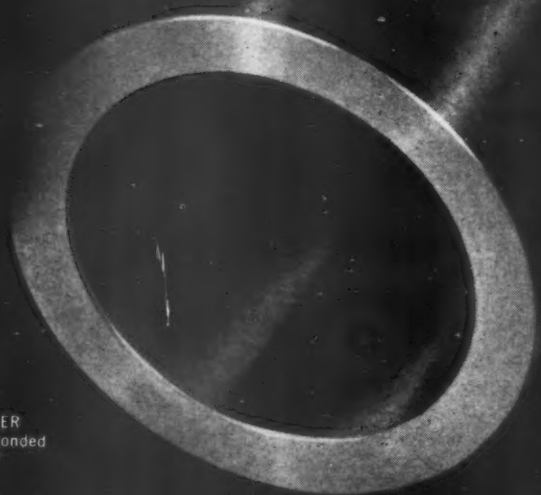

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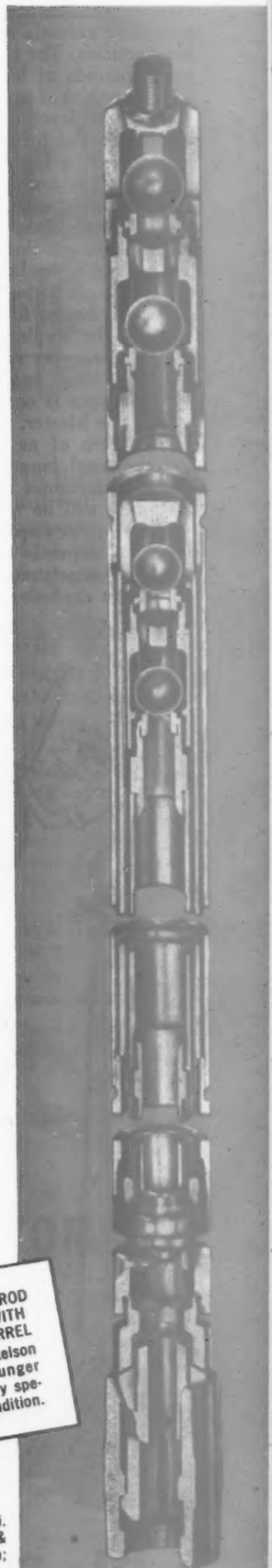

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PR-21

charge is made from canvas impregnated with plastic, the ends being made from a specially selected thermal-setting plastic, and the lower end particularly being of cellular construction with a platform to provide a shock insulating medium between explosive and propellant. No metal is used in the construction of the bomb which under the high explosive stresses disintegrates completely, thus obviating the danger of people or animals being injured by flying particles. The charge consists of 10 to 12 pounds of high explosive.

The method of firing the charge at the appropriate level is simple, but rather ingenious. The firing squib and propellant, usually a low velocity powder, are placed in the lower end of the mortar, and the bomb, with its detonator cap is placed above them. The squib is connected through the firing circuit with one arm of a dual blaster. The detonator cap is connected by a light weight, insulated, duplex firing line to a special switch. The duplex conductor is fastened at its upper end to the bomb case and at its lower end to the firing switch which in turn is connected to the other arm of the blaster. The slack is wound in the form of an Archimedan spiral and the total length of this cable obviously determines the height at which the bomb will be fired.

The frequency spectrum generated by the bomb depends largely on the manner of its construction and the properties of the explosive. Design is thus an important matter. As for the explosive, a high velocity material will generate more high frequency components than a low velocity material and the high velocity material will also generate a steeper wavefront. This will result in a total shock wave with a greater proportion of seismic energy. Part of this energy, however, may be comprised of frequency components that accentuate random interference.

The bomb is so contrived that when the effective frequencies of the predominant energy components strike the earth's surface, they are within that frequency band that will allow maximum transfer of energy through the weathered zone and will at the same time give optimum reflection efficiency.

According to Dr. Jakosky, there are usually in aerial shooting certain manifestations that diffuse or mask the significant reflections. The duration of these masking effects is a function of the position of the shot and the spread length—the higher the elevation of the explosion, the shorter the duration of the masking effect, and, by the same token, the greater the off-set distance, the shorter the masking time. As a result of the work so far done in air shooting by this method, it has been established that the proper height for the explosion is one at which the horizontal component of velocity of the air wave is different from the phase velocity of the ground wave through the surface layer. That level apparently varies for different type areas, but can be quickly determined for any set of conditions.

Various types of interference were discussed by Dr. Jakosky in his presentation, and seismic reflections secured under a variety of conditions were analyzed. A method of determining the depth and velocity through the weathered zone was also defined. This consisted of making a shallow refraction shot at the point occupied by the mortar, using about two pounds of explosive attached to a small stake. The depth and velocity through the weathered zone is calculated directly from the first arrival times and is thereafter used to correct first arrivals from the two sides of the spread.

The entire process is a development of real consequence to both the oil finding scientists and to the petroleum industry at large. For the exploration group, it promises a faster and less expensive means of geophysicising in those areas in which sufficiently clear recordings can be obtained by the air shooting technique. For the petroleum industry, it greatly extends the territory accessible to geophysical exploration.

There is little doubt that as further experience is acquired in the development of equipment and in the procedural details of the method itself adaptations and improvements will take place and aerial shooting will evolve from its current "novelty" status to a generally practiced and approved method. ***

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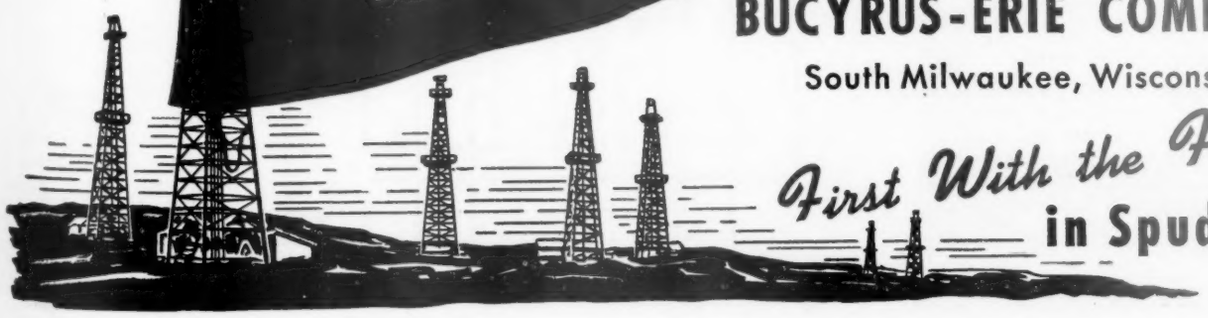

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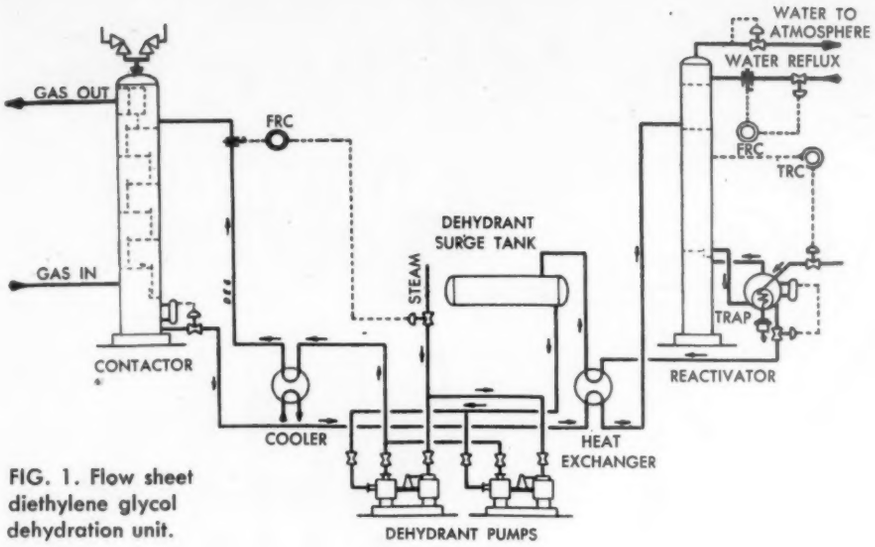


FIG. 1. Flow sheet diethylene glycol dehydration unit.

the gas and collects behind orifice plates, valve ports, and in control supply lines or piping where it is subject to freezing. Trouble begins almost immediately in cold weather.

The formation of hydrocarbon hydrates is another serious cause of trouble and may be defined as the formation of a crystalline chemical compound that produces ice. Hydrates are a more complex problem as they often freeze at a temperature considerably above 32 F, which is the normal freezing point of water. The effect of increased line pressure is to increase the temperature at which hydrates will form. Thus a line operating at 800 psi may develop a hydrate block at one point and the pressure build-up back to the well will aggravate the condition.

Methods of Dehydration

The most logical approach to the problem of freezing is the removal of

Prevention of Freezing in Measuring and Regulating Equipment

DON ATTAWAY*

THERE was a time when the trouble and worry of equipment freezing vexed the measurement man for only short periods of the year, usually during extremely cold weather. That was in the days of low pressures, short lines, light volumes, and small sized pipe. But like the 100-cents dollar, that day has passed.

With the advent of gas production from deeper structures at high pressure and improved materials and methods, transportation systems of large size handling huge volumes are the rule rather than the exception. Consequently, the freezing problems have multiplied like the proverbial rabbit. Not only is measurement knocked into a cocked hat, but regulation of pressures and volumes becomes almost impossible and freezing is virtually a year round problem.

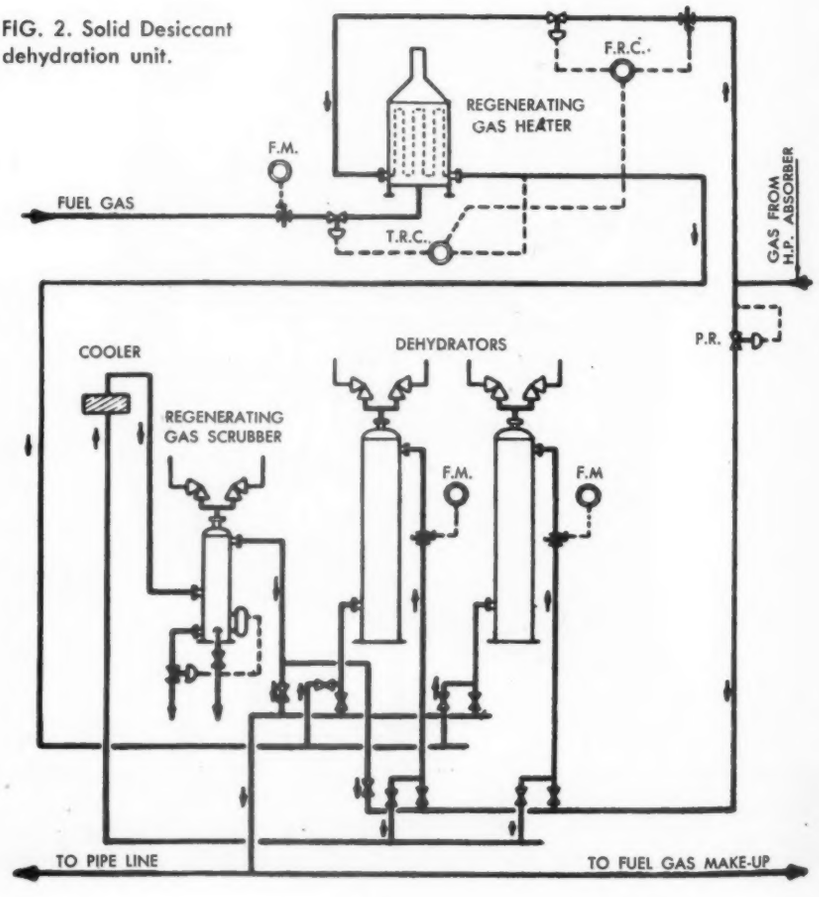
The paradox of the problem is that freezing is caused by several separate things and often radically different treatment and correction is necessary to eliminate the causes.

Causes of Freezing

The principal source of trouble is water vapor. Natural gas is practically saturated as it leaves the well head and with a drop in temperature of the gas, this vapor condenses to form free water in the pipe line. This water travels with

*Arkansas Fuel Oil Company, Shreveport, Louisiana.

FIG. 2. Solid Desiccant dehydration unit.



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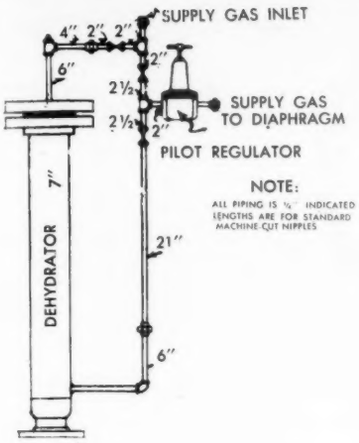
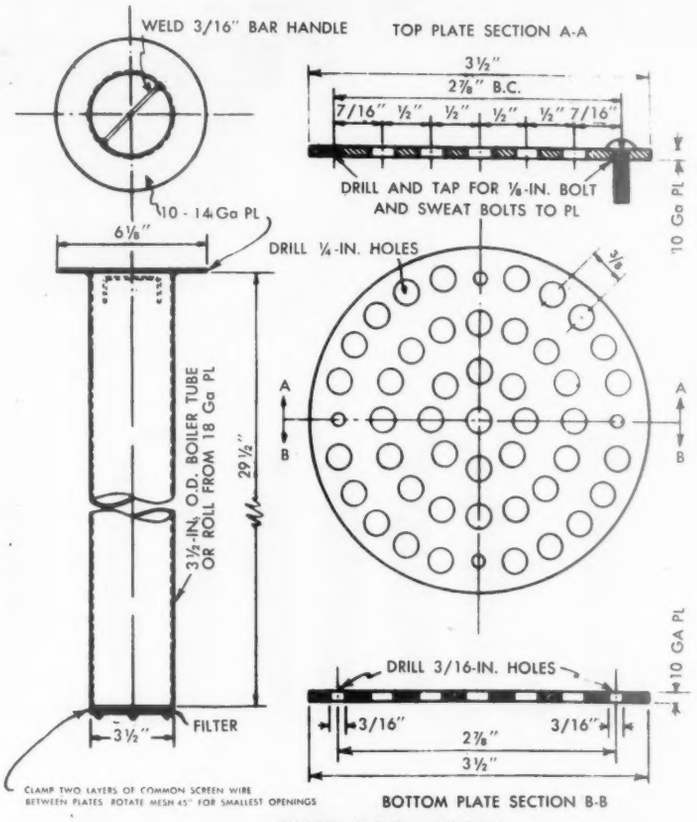


ASSEMBLY OF DEHYDRATOR AND PILOT REGULATOR.



FILTER PLATE DETAILS.

FIG. 3.

water vapor in gas at the source of production to such an extent that the dew point will not be reached at the lowest temperature at which the gas passes. There are several methods for accomplishing this but no one cure-all solution. This is called dehydration and there are several general types. Some of the most successful in use today are as follows:

A. Absorption type, using a continuous circulation of a hygroscopic liquid. Such a process might make use of diethylene glycol, lithium chloride, glycerine, zinc chloride or many other water absorbing chemicals. Fig. 1 shows a typical diethylene glycol dehydration unit.

B. Dessicant type, using a moisture adsorbent material in solid or granular form. Such a process might use activated alumina, bauxite, sovabead, charcoal or any of several solids with water adsorbing qualities. Fig. 2 shows a typical solid dessicant type dehydration unit.

These plants are generally located at a centralized point on main gas lines after the gas has been produced and gathered from the well. Freezing troubles from this point down the line usually diminish or disappear after dehydration, but problems arise and are usually present at the well and in the gathering system.

One solution to the problem of freezing at high pressures makes use of dessicant dehydration of the gas supply to controls and regulators. A miniature dehydrator can be constructed that is inexpensive and successful. Such a dehydrator is shown in Fig. 3. This device was designated by L. S. Reid and uses 4-8 mesh activated alumina or Florite as a solid dessicant. A similar device using charcoal is used by many companies.

Some companies have even made meter pots similar to this dehydrator and installed them in the piping on each side of the orifice flange. Some success and a few failures have been reported. A leak proof assembly is an absolute necessity to prevent freezing.

Inhibitors

The injection of inhibitors such as ammonia, alcohol, or commercial solutions into gas pipe lines is sometimes used in an emergency, but the method is quite expensive, offers only temporary relief, and results are often none too good.

Heat—Direct Fire

Heat is the most generally accepted solution to freezing of meters and regulators. Many companies have installed direct-fired heaters on lease and gathering lines. Fig. 4 shows a typical lease heater. This heater is a small boiler filled with water through which tubes pass to conduct the gas in and out. It is

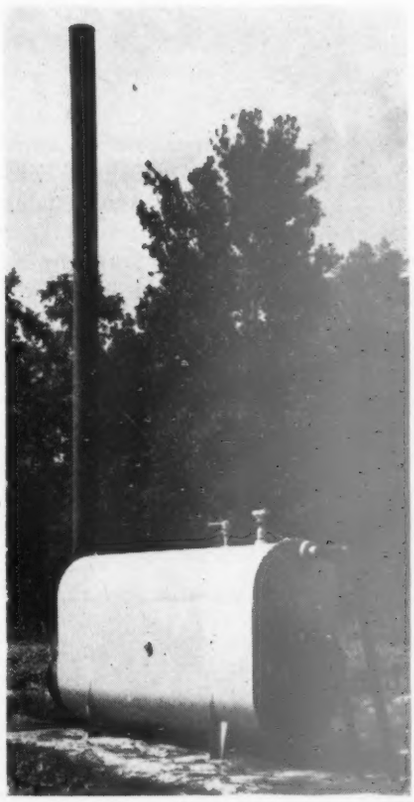


FIG. 4. A typical direct fired gas heater showing inlet and outlet connections.

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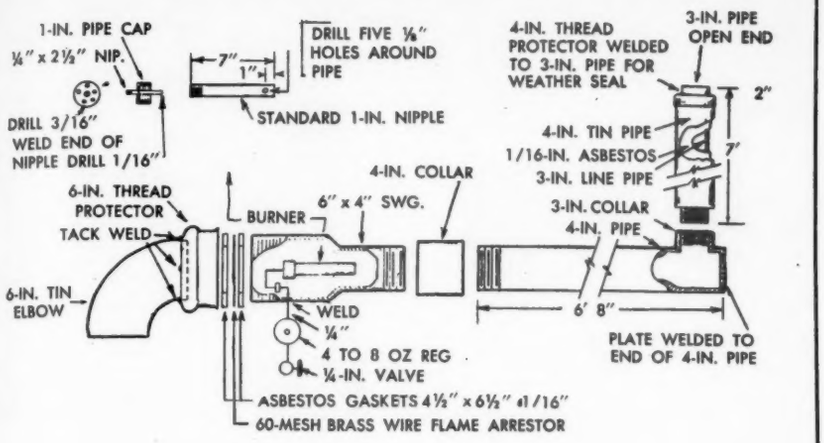


FIG. 5. Meter house heater.

automatically controlled to a temperature well above the hydrate point. Sometimes the gas is heated as high as 200 F.

This hot gas is sometimes used to prevent meter and regulator freezing by tracing the instrument and piping with copper tubing through which the hot gas passes. A regulator body well wrapped and insulated can be kept very hot even in the coldest weather. Installations have also been made on orifice meters, taking a supply of the hot gas from the bottom tap of the up-stream orifice flange and tracing the piping and chambers with copper tubing and discharging back into the down-stream bottom tap of the orifice flange. This amount of unmetered gas is negligible in large delivery installations.

Another common and practical method of providing direct fired heat is the installation and use of a meter or regulator house heater. The amount of gas used by such a heater is small and the house becomes a more comfortable place for the meterman on cold days. Temperatures in the house and manifold will tend to equalize and less condensation in piping and pots will be found, thus reducing maintenance.

House heaters can be bought or made by the individual to suit his special requirements. In either case, they must be 100 per cent explosion proof. Fig. 5 shows a typical house heater that can be constructed at a reasonable cost.

Heat—Steam or Hot Water

Steam heat is also very successful in preventing freezing. The problem is in obtaining a constant supply of steam. Around gasoline plants, compressor stations and such, there is often an ample supply of steam or hot water that simplifies the problem.

The practice of blowing live steam or hot water on controls, meters, and regulators is not only dangerous but it is wasteful and actually damages the equipment and creates a wet, sloppy, and muddy working area.

The most sensible and effective use of steam or hot water is to wrap the instrument with copper tubing or pipe and insulate it. Sometimes a removable jacket can be placed around the valve body, regulator, or meter. Such a jacket holds the heat, lowers the consumption, and keeps a clean, dry area. Exhaust steam is more desirable for such heating than live steam as the pressure and temperature is generally lower and more hot water present.

Heat—Electrical

Another method for the prevention of freezing is the use of electrical heat or energy. Whenever electrical current is available, there are at least three types of heaters that might be suggested. They are:

1. Strip heater.
2. Cartridge heater.
3. Calrod heater.

The strip heater is mounted in a 2 by 14-in. brass nipple having a cap on one end and a reducer on the other. The strip is wrapped on each end with 2-in. asbestos tape to hold it in place in the center of the nipple. The entire assembly is then wrapped with asbestos tape on the line or equipment where freezing is encountered.

The cartridge heater is best installed in a metal block to act as a heat transmitter. The gas to be heated is piped through the block.

The calrod heater element is simply wound around the pipe and then wrapped with insulation.

All these electrical units operate on 110-115 v circuits and draw about 200 to 250 w. There have been many successful installations of electrical heating. Fig. 6 shows the three units mentioned.

Miscellaneous Devices to Prevent Freezing

Sometimes the prevention of freezing is a simple matter and does not involve the use of any special devices. Simple changes in the installation or its fittings often solve the problem.

An example of this is a well authenticated case in a South Arkansas field where considerable difficulty was experienced in measuring high pressure gas. Freezing developed almost field-wide in meter piping, chambers, and needle valves.

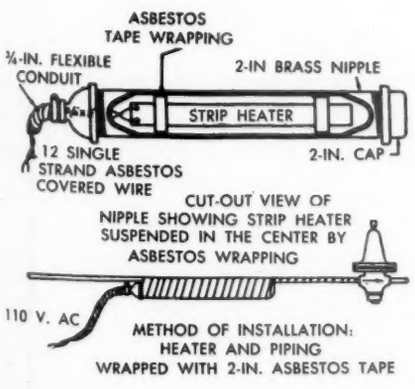
First, the piping was enlarged from ¼ to ½-in. and the needle valves replaced with plug valves, the majority of freezing troubles disappeared.

Some installations that continued to freeze were found to have leaks in the piping. When these were repaired, the freezing stopped.

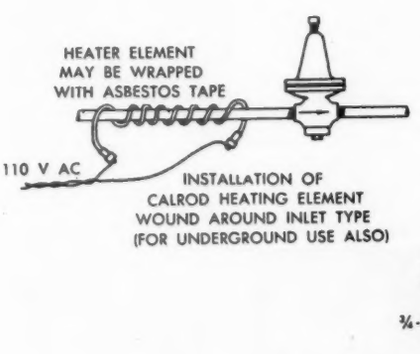
Other installations that continued to freeze were repiped so that all piping was kept to the barest minimum and installed so as to drain back into the flange.

A final few meters continued to freeze but after either the installation of meter covers or houses, wrapping with insula-

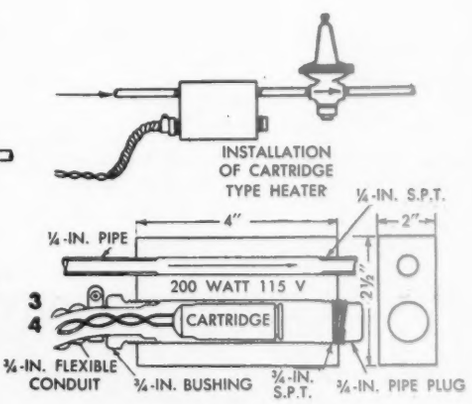
FIG. 6.


ASBESTOS TAPE WRAPPING
¾-IN. FLEXIBLE CONDUIT
2-IN BRASS NIPPLE
STRIP HEATER
12 SINGLE STRAND ASBESTOS COVERED WIRE
2-IN. CAP
CUT-OUT VIEW OF NIPPLE SHOWING STRIP HEATER SUSPENDED IN THE CENTER BY ASBESTOS WRAPPING
110 V. AC
METHOD OF INSTALLATION: HEATER AND PIPING WRAPPED WITH 2-IN. ASBESTOS TAPE

STRIP HEATER


HEATER ELEMENT MAY BE WRAPPED WITH ASBESTOS TAPE
110 V AC
INSTALLATION OF CALROD HEATING ELEMENT WOUND AROUND INLET TYPE (FOR UNDERGROUND USE ALSO)

CALROD HEATER



CARTRIDGE HEATER

Fig. 108AA Acme Alloy Drilmor Bit

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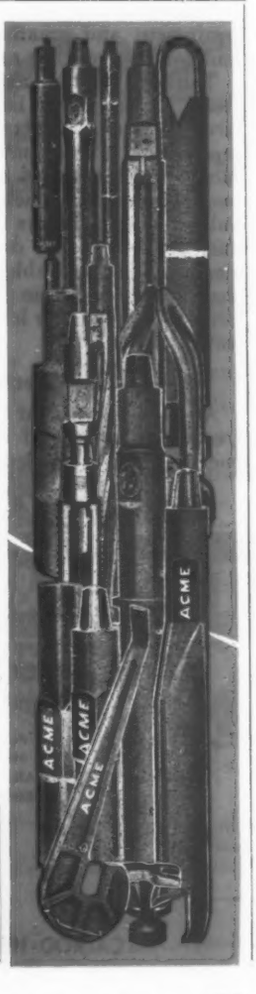

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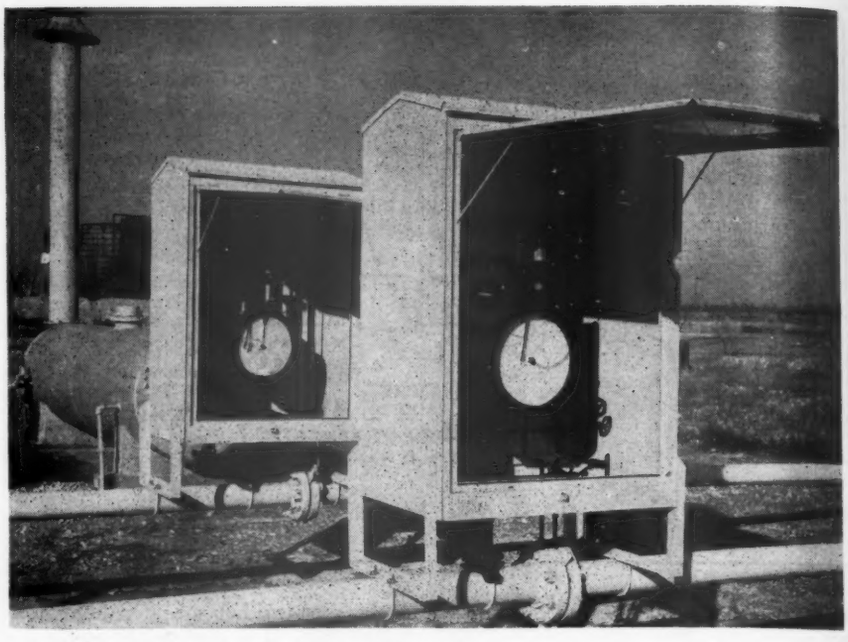

FIG. 7. An example of meter housing that tends to eliminate freezing in open and closed locations.

tion, and tracing with gas from the line, all freezing disappeared.

Conclusion

It is quite obvious that the first requirement to prevent freezing in measuring and regulating equipment is a complete program of inspection and maintenance. Working parts must be properly lubricated and all piping kept clean and free from liquid and leaks.

A second consideration is the lay-out and location of the equipment. Measuring and regulating stations located at high elevations in open areas toward the north are naturally subjected to more severe weather conditions than locations in low and protected areas.

Finally, it is imperative that gas actuating the mechanism of meters and regulators must be dry and void of all water if freezing is to be prevented.

As a final word, gas is highly inflammable and explosive and the use of open flames of any kind to heat, thaw or warm meters or regulators is highly dangerous.

Even the use of live steam has its hazards to personnel.

The use of hot water (not boiling) is suggested only in cases of emergency.

Undoubtedly, freezing problems will continue to arise and new and different conditions develop to plague the measurement man, but there are few that cannot be solved if all the facts are taken into consideration and the proper approach made toward the solution. In my opinion, open and free discussion with other measurement men concerning their problems and experience is of tremendous value in learning new ways and means to defeat one of the measurement man's most potent enemies—freezing.

References

1. *Dehydration of Supply Gas to Prevent Freezing* by L. S. Reid—*The Petroleum Engineer*, January, 1945.
2. *Natural Gas Dehydration* by D. N. Barrow, *Petroleum Refiner*, December, 1948.
3. *Prevention of Freezing in Measuring and Regulating Equipment* by W. A. Brewster, University of Oklahoma, April, 1948.
4. *Prevention of Freezing in Measuring and and Regulating Equipment* by John R. Bird, University of Oklahoma, April, 1946.

* * *

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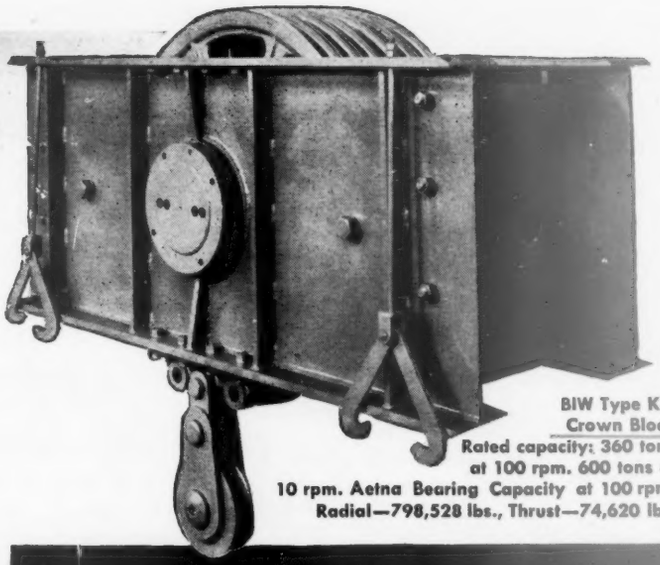

BIW Type KN Crown Block
Rated capacity: 360 tons at 100 rpm. 600 tons at 10 rpm. Aetna Bearing Capacity at 100 rpm. Radial—798,528 lbs., Thrust—74,620 lbs.

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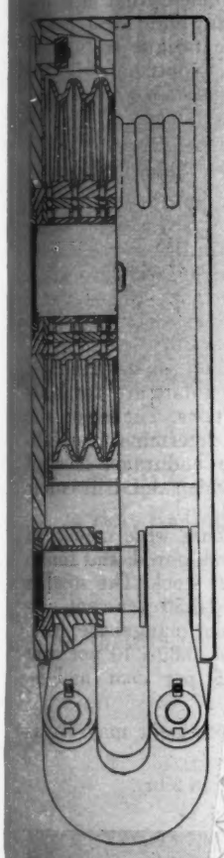

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Methods for Improvement of Drill-Collar Joints Evaluated by Full Size Fatigue Tests†

L. E. TRISHMAN*

SELECTION, application, and proper field handling of drill collars undoubtedly contributes most to their satisfactory performance and the maximum service obtainable. The importance of good drill collars in a drill string cannot be too highly stressed. Even though a drill collar appears to be a fairly simple piece of drilling equipment, it is necessary to expend a considerable amount of metallurgical engineering and mechanical design knowledge in order to produce a longer lasting collar.

MacDonald and Lubinski[1] have studied the effect of drill collar size on the straightness of hole obtainable and have made definite recommendations for drilling practice in crooked-hole country. Caution has been given concerning the placing of more weight on the bit than that which approaches the critical amount necessary to cause buckling of the drill collars.

Moore[2] mentions that the greater portion of drill collar failures in the field are the result of fatigue at the connections, either simple fatigue in the pins or corrosion fatigue at the boxes. Excessive transverse loading on the joints produced by excessive weight on the bit, with the attendant drill collar buckling, or drilling in a crooked hole will produce early failure by fatigue.

Metallurgical factors that affect drill collar performance have been discussed by Stoup[3]. The advantage of fully heat-treated collars, stress relieved after straightening, have been brought out. A unique chart as an aid to the selection of the optimum taper-joint connection to be used on a collar of a given bore and outside diameter has been presented. By the use of this chart, grossly unbalanced proportions in the pin and box can be avoided.

From time to time various ideas have been proposed to improve drill collar threaded joints. From some of these ideas, improved joints now in service in the field have evolved. Although field use is the ultimate in testing, the results are slow in coming forth. In some cases they are not too reliably ascertained and in others, where the design or improvement had not been completely developed, the results may discredit a product that, under more favorable circumstances, might have been satisfactory. To avoid some of these difficulties and to be sure that a more completely developed product is presented for final field testing, a fatigue machine was built which would enable tests to be made on full-size joints. This machine, of the rotating cantilever beam type, is shown in Fig. 1. All fatigue tests reported here were made in this machine.

It is not the purpose to present herein new designs of drill collar joints nor to present comparative tests on existing designs, although actual basic fatigue data on various joint designs seems to be lacking. Rather, it is intended to present information regarding possible methods of improvement that are applicable to almost any joint design and to show by full-size fatigue tests what these methods will contribute in the way of increased resistance to fatigue failure of drill collar joints.

The Author

L. E. Trishman is chief research engineer for Spang-Chalfant Division, The National Supply Company. A graduate of Ohio State University, he joined Carnegie-Illinois Steel Corporation in its metallurgical department in 1935, and later was employed by Firestone Steel Products, returning to Carnegie-Illinois as research metallurgist shortly thereafter. He has been with Spang-Chalfant Division since the fall of 1940, first as metallurgical engineer, then as chief metallurgist.

Basic Fatigue Test Date

Before any serious work could be carried out to develop or test new ideas for joint improvement, it was necessary to establish some base from which to work. A wealth of fatigue data are available on small fatigue tests, determined on highly polished laboratory test bars of small size, about 0.300 in. in diameter, whereas not too much data are available on full-size fatigue tests. Therefore, the starting place is to determine at a full-size scale the fatigue endurance level of the material from which the drill collar joints are machined.

All full-size test bars were machined from mill heat-treated, bored, and rough machined drill collar stock. The steel is AISI 4140; i.e., 0.40-0.50 per cent carbon, 0.75-1.00 per cent manganese, 0.20-0.35 per cent silicon, 0.80-1.10 per cent chromium, 0.15-0.25 per cent molybdenum.

A typical heat treatment may be as follows:

1. Heat to 1600 F in 5 hr.

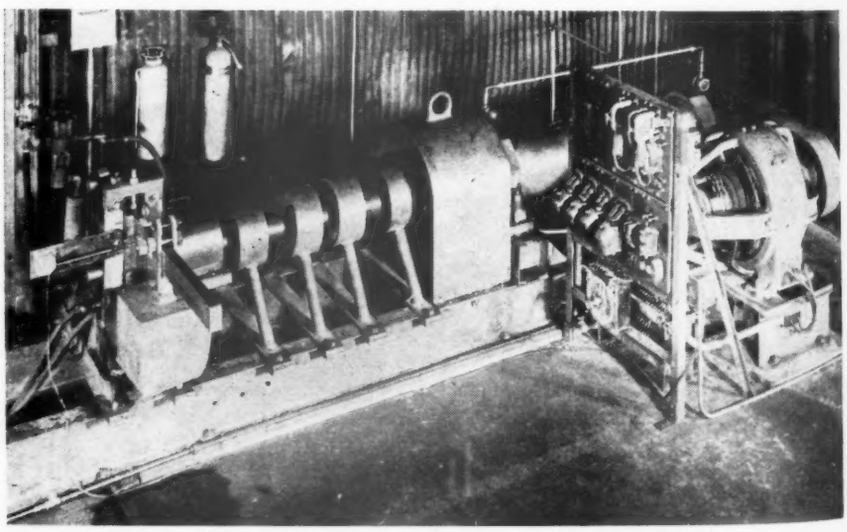

FIG. 1. Fatigue machine completely set up with guards attached ready to run.

†Presented at the spring meeting of the Southwestern District, Division of Production, Washington-Youree Hotel, Shreveport, Louisiana, March 5-6-7, 1952.

[1]References are at the end of the paper.

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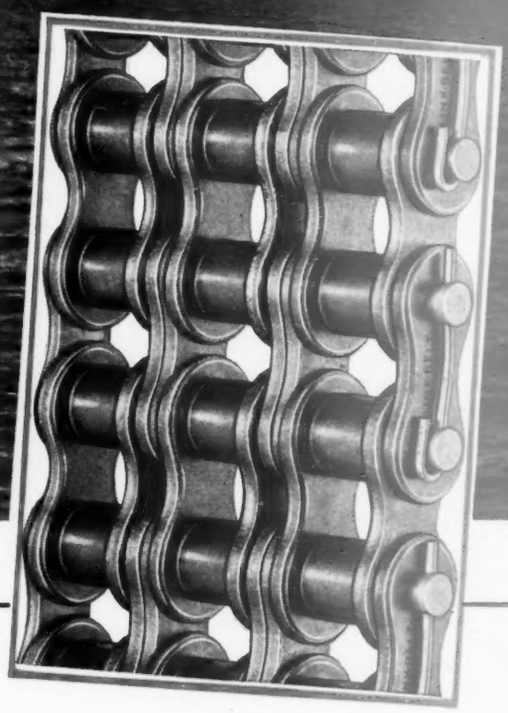

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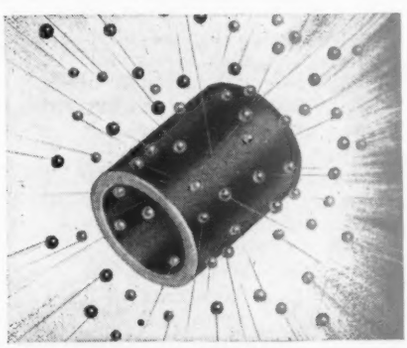

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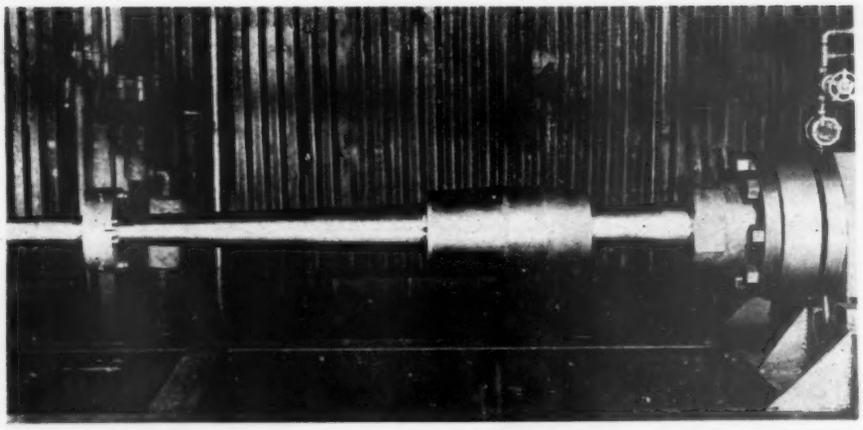


FIG. 1a. Fatigue bar shrunk into adaptors and mounter on spindle of fatigue machine.

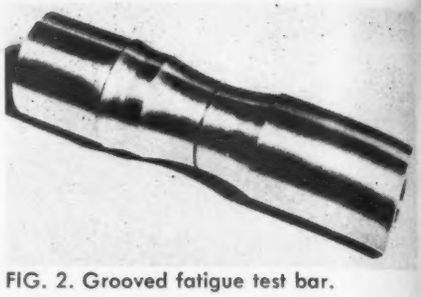


FIG. 2. Grooved fatigue test bar.

2. Hold at temperature 4 hr.
3. Water quench to 400 F.
4. As soon as equalized, place in warm furnace.
5. Heat to 1150 F in 3 hr.
6. Hold at temperature 4 hr.
7. Air or water cool.
8. Straighten and stress relieve at 1050 F for 3 hr.

Inasmuch as the most vulnerable place for fatigue failure in a drill collar joint is the last-engaged thread, it was decided to make a grooved test bar with a 2¼ in bore, approximately 5¾ in. OD (as shown in Fig. 2) for determination of the basic data. The neck of the bar was turned to a 10 in. radius with the diameter at the neck of 4.607 in., which was taken as the thread-crest diameter of the last full thread of a 4½ in. full-hole joint. From this diameter a groove comparable to a last-engaged thread groove of full thread depth was cut to a diameter of 4.372 in. with a tool ground to exact thread form of the 4½ in. full hole, with 0.020 in. radius of truncation. This produces a groove of 0.1175 in. in depth.[4] The cutting tool was checked with a tool maker's microscope for conformance to the shape of the exact thread form and radius of truncation. The finished test bar, then, is a simple notched fatigue bar with a notch of depth and shape equivalent to the last-engaged thread of the 4½ in. full-hole joint. Such a test bar is free of the variables of stress caused by make-up of a threaded joint, as well as of other variables that might influence the accuracy of test results and produce unnecessary scatter of test values. Therefore, the bar was designed to give basic data of a notch-fatigue test character of a pre-stress-free notch comparable to a last-engaged thread in form. The cylindrical portions of the test bar are of such a length and diameter as to give firm support and tight gripping when the adaptors of the fatigue machine are shrunk onto the test bar ends.

Extensive tests were made to determine the basic notch-fatigue curve for the drill collar heat-treated steel from carefully prepared fatigue bars in which the notch was cut to full thread depth with no other treatment applied. The data from 12 tests, when plotted, gives a notch endurance limit of 10,000 ft-lb bending moment at the plane of the notch (Fig. 3). The results are given in foot-pounds bending moment because it is not possible to calculate the exact stress at the bottom of the notch in pounds per square inch, inasmuch as the stress concentration factor is not known. This factor could be determined by running tests on unnotched bars and calculating the factor therefrom; but for comparison purposes the stress at the notch is not needed.

Fatigue Tests of Nitrided Notched Bars

It is well known metallurgically that nitriding the surface of smoothly machined parts greatly improves the fatigue resistance. Although 4140 steel is not strictly a nitriding steel, it contains sufficient alloying elements to enable a good nitride layer to develop on its smoothly machined surface. Therefore, nitriding the threaded joints of drill collars should improve their fatigue resistance, especially since the nitride layer is also more corrosion resistant and could thereby enhance the corrosion-fatigue resistance, particularly at the last-engaged thread zone of the female member.

Carefully machined test bars were nitrided for 100 hr at 950 F with the flow of ammonia gas through the furnace chamber adjusted to produce a dissociation of 30 per cent. A nitride layer of the quality and depth shown in Fig. 4 was obtained under these conditions, yet the temperature of treatment is sufficiently low as not to alter the base metal properties obtained from the original heat treatment. Such a layer has a hard-

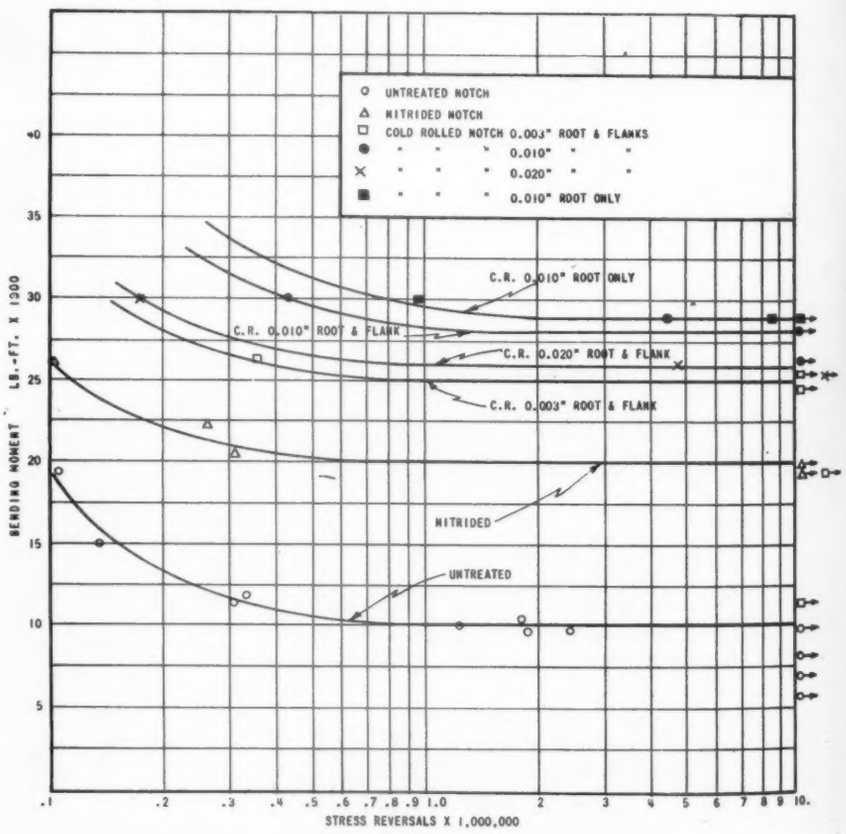
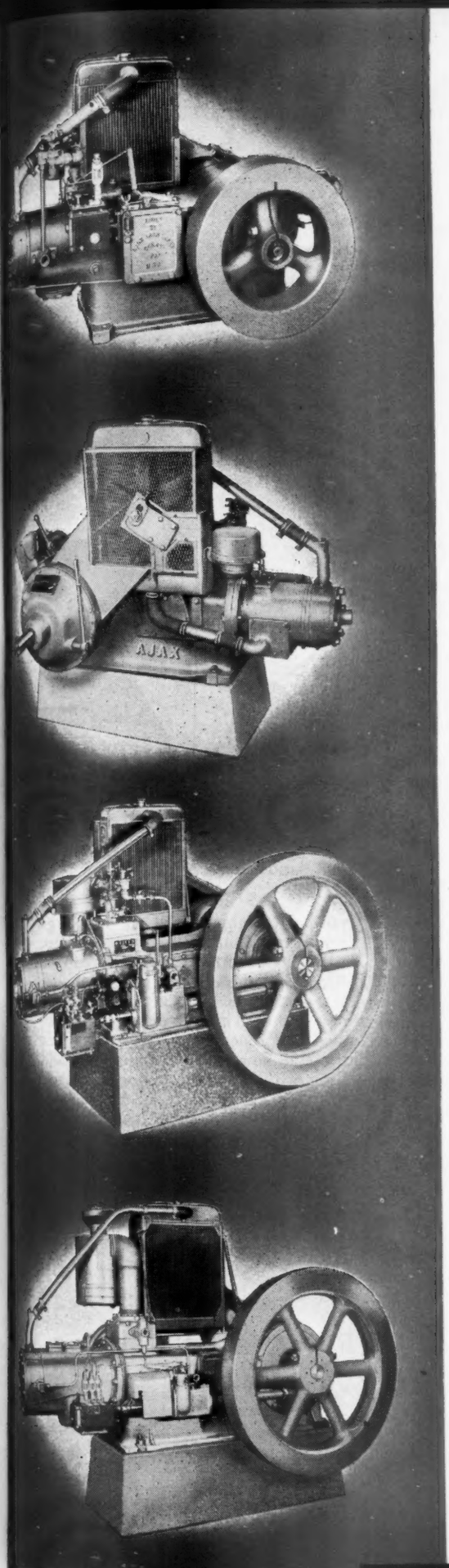


FIG. 3. Full size notched bar fatigue tests.

Notch diameter equal to last engaged thread diameter of 4½" F.M. drill collar joint.



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Fatigue tests of the nitrided bars gave surprisingly high results. An endurance limit of about 20,000 ft-lb bending moment was indicated that is 100 per cent improvement over the untreated tests. (See Fig. 3 for comparison.) In spite of this great improvement in the notch-fatigue endurance limit, nitrided threaded joints were found to be unsatisfactory.

Apparently the very high hardness of the nitride layer at the root of the thread, in combination with the sharpness of the notch at the root, resulted in notch embrittlement. When an attempt was made to buck up nitrided threaded drill collar joints, the threads failed by cracking at the roots and stripping off at torque values as low as 14,000 ft-lb, which is considered too low for good make-up practice (Fig. 4a). Therefore, the nitriding method was rejected from further consideration as a means of improving the fatigue resistance of drill collar joints.

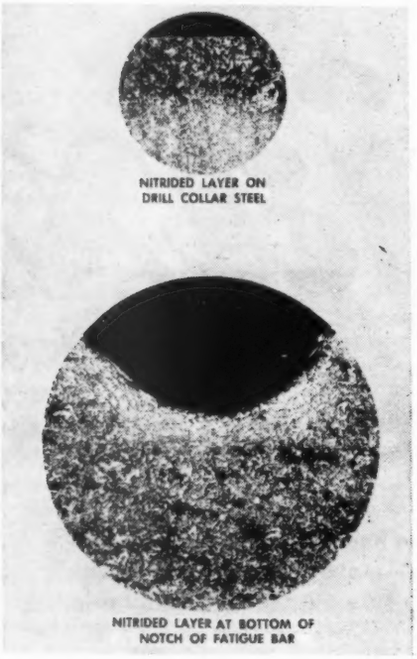

FIG. 4.

Cold-Rolled Notch-Fatigue Tests

The cold rolling of threads on bolts and other machine parts to allay fatigue failure has been practiced for many years. Only recently has the cold working of threads been applied to oil well drill collar joints. The benefits to be derived from cold working of threads can be considerable. On the other hand, if careful control of the cold-working process is not exercised, the metal may be damaged to the point where failure may take place sooner or at lower loads than if cold working had not been attempted at all. To determine the extent of cold work permissible and the amount of benefit to be derived by cold rolling of threads, some fundamental tests were made by rolling a circumferential thread-form groove to different degrees of cold work in full-size fatigue test bars.

The test bars for this work were made the same as those for the previous tests of the untreated and of the nitrided notched bars, except that the circumferential thread-form groove was cut shallow by the required amount to give the degree of cold work desired when rolled to full thread depth. For example, if a test bar was required with the groove cold rolled to a depth of 0.005 in., the 60 deg, 0.020 in. truncated thread-form groove would be cut 0.005 in. shallow with the ground form tool. This groove would then be cold rolled 0.005 in. deeper with a roller ground to the exact thread form, thereby producing a groove of exact thread form and of full depth of 0.1175 in. In this manner, grooves of a constant depth but with different degrees of cold rolling were obtained.

The groove rolling device, Fig. 5, was built on the order of a large nut cracker in which three rolls ground to the thread form are installed in the jaws. To use the device, it is placed around the test bar in a lathe with the three form rollers following the previously shallow cut groove. By tightening down the large screw at the right as the test bar rotates slowly in the lathe, the groove can be rolled to any desired depth. The smaller screw with its lock nut acts as a stop so that a setting to a given depth can be obtained and repeated. Fig. 6 shows how the metal flows as the degree of cold rolling or the depth of rolling increases. All grooves are rolled to the same depth, measured from the bar surface. Obviously, if the degree of rolling were increased far enough, the rolls would act similar to the cutters of a pipe cutter and considerable damage to the metal at the root of the groove would take place. Sections for examination under a metallurgical microscope were cut from the

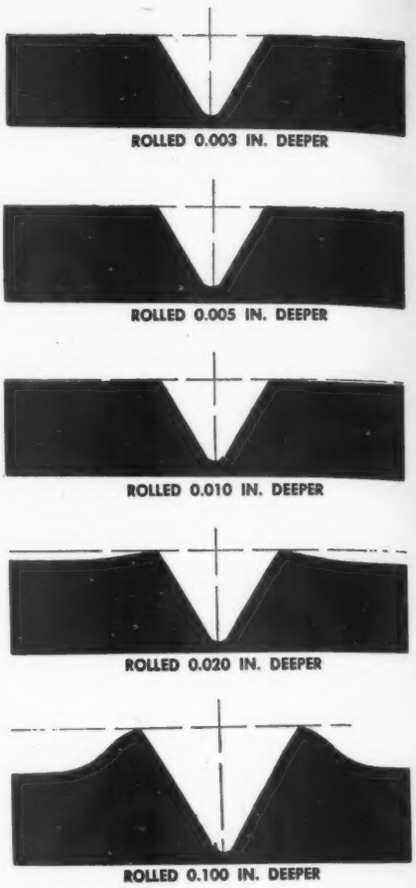

FIG. 6. Contour of rolled grooves in drill collar stock. Grooves rolled to full thread depth.

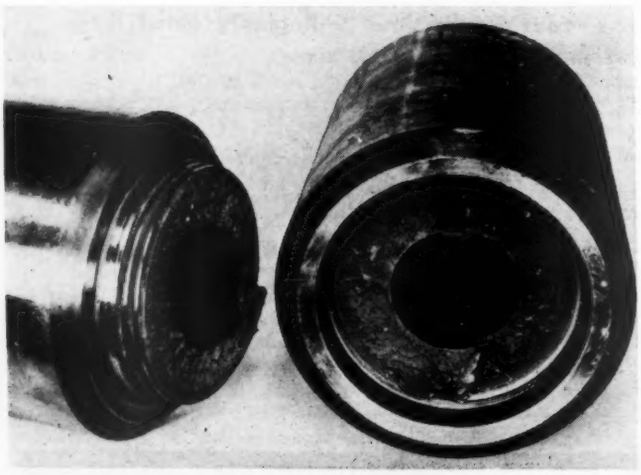

FIG. 4a. Fractured nitrided drill collar joint.

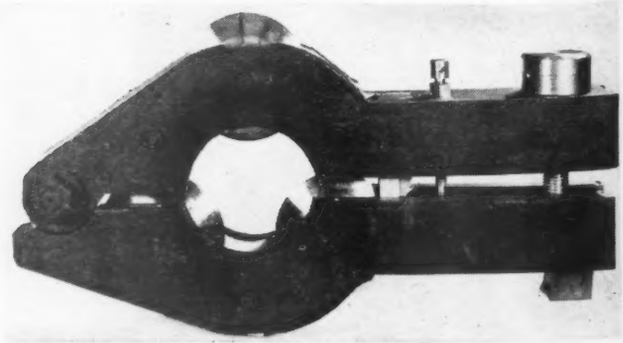

FIG. 5. Device for cold rolling groove in full size fatigue test bars.

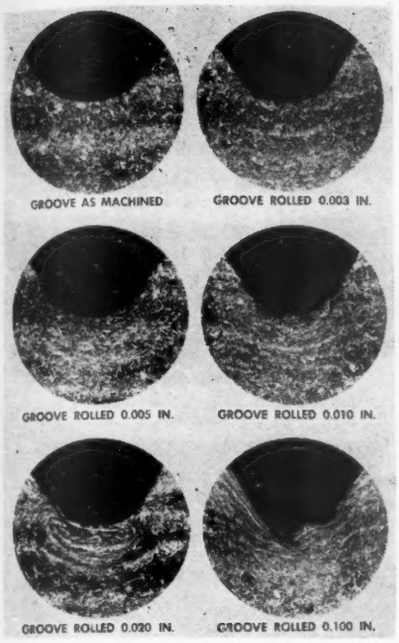

FIG. 7. Photomicrographs of grooves rolled to various depths showing effect of cold rolling. Etched in nital.

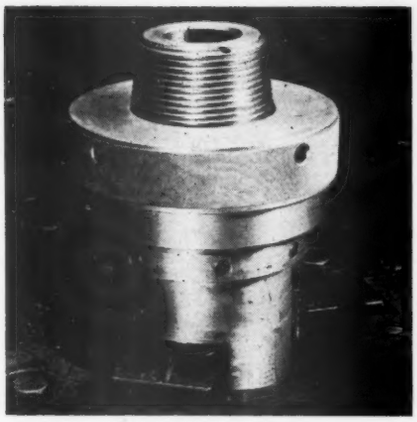

FIG. 9. Equipment for aligning the flanged ring with the drill collar shoulder face.

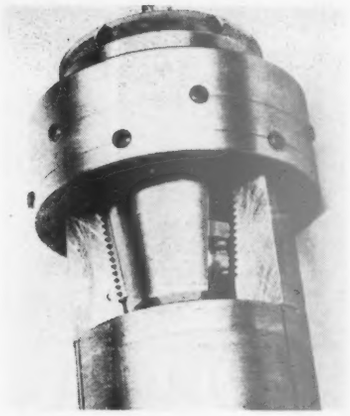

FIG. 10. Close-up of internal thread rolling device showing fully engaged work roll and back-up shoe.

roots of the grooves rolled to increasing depths to determine the metal flow and observe the degree of damage to the grooves severaly rolled. The photomicrographs of Fig. 7 indicate that the depth of rolling probably should not be increased much beyond 0.010 in. or cracking of the root metal results.

Full-size fatigue bars with the grooves rolled to different degrees of cold work were tested at different loads and the corresponding S-N curves plotted. These are shown at the top of Fig. 3. Apparently rolling the notch to only 0.010 in. produces the optimum in fatigue endurance at a level of about 28,000 ft-lb bending moment, inasmuch as rolling to 0.020 in. gives a lower endurance level, and rolling to less than 0.010 in. also gives a lower endurance level. The improvement in resistance to fatigue failure obtainable by cold rolling is substantially greater than that obtained by nitriding.

When the thread-form notch is cut with a tool of exact form and then rolled with a roller of exact form, deformation of the metal takes place along the flanks as well as in the root. Apparently cold working of the flanks is not necessary, because rolling the root to only 0.010 in. deformation gives an endurance level comparable to that of tests with the root and flanks rolled the same amount. To roll the root only, the thread-form cutting tool was ground to 0.030 in. truncation instead of the usual 0.020. in. The extra 0.010 in. of metal left in the root of the groove with this tool is then rolled down with the roller which is ground to 0.020 in. truncation. This cold works the root only and slightly polishes the flanks with the wiping section of the roll when at full depth.

Thread Rolling

The great improvement in fatigue resistance obtained from the cold-rolled notched-bar fatigue tests indicated that further investigation of thread rolling was in order. The tests also indicated, however, that careful control of the rolling process would be necessary if a rolled threaded joint was to be obtained in which the base metal at the thread root was not to be damaged by the rolling process but rolled just a sufficient amount to produce the optimum in fatigue endurance improvement.

Rolling the root of a tapered thread with the necessary control is quite a problem. First attempts were made in a lathe with a tool-post mounted roller but it was soon discovered that necessary alignment could not be readily obtained. The takeup or play in the gibs, taper attachment, and screw in the cross

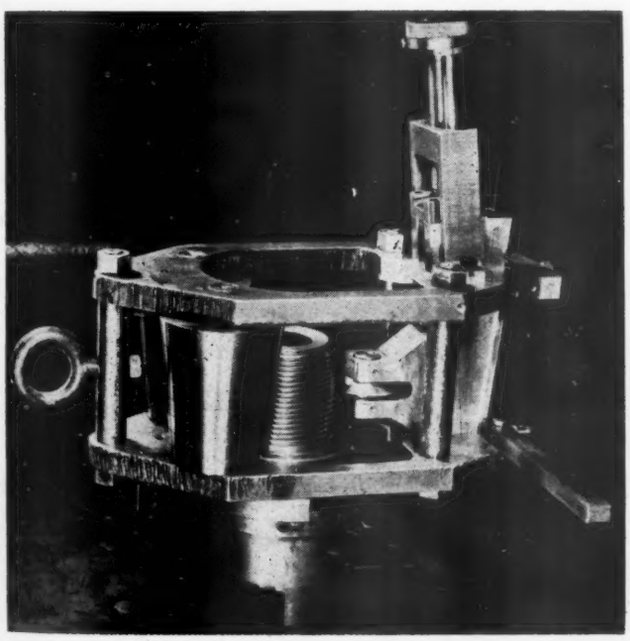

FIG. 8. Pin thread rolling device ready for operation.

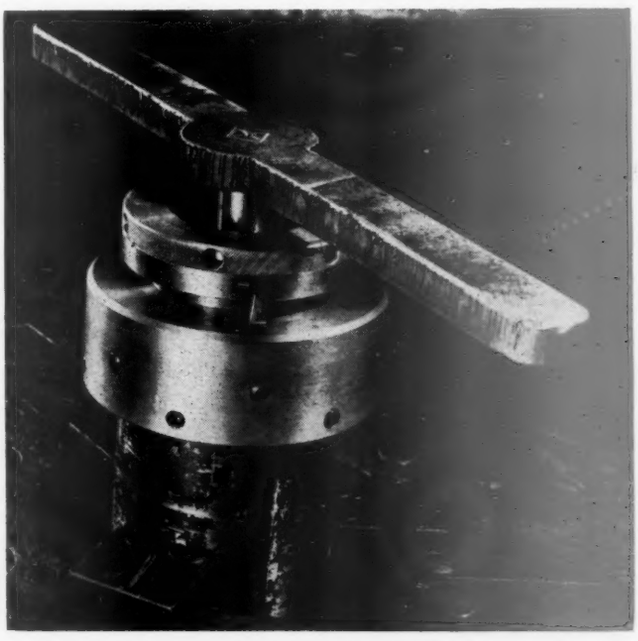

FIG. 11. Internal thread rolling device ready for operation.

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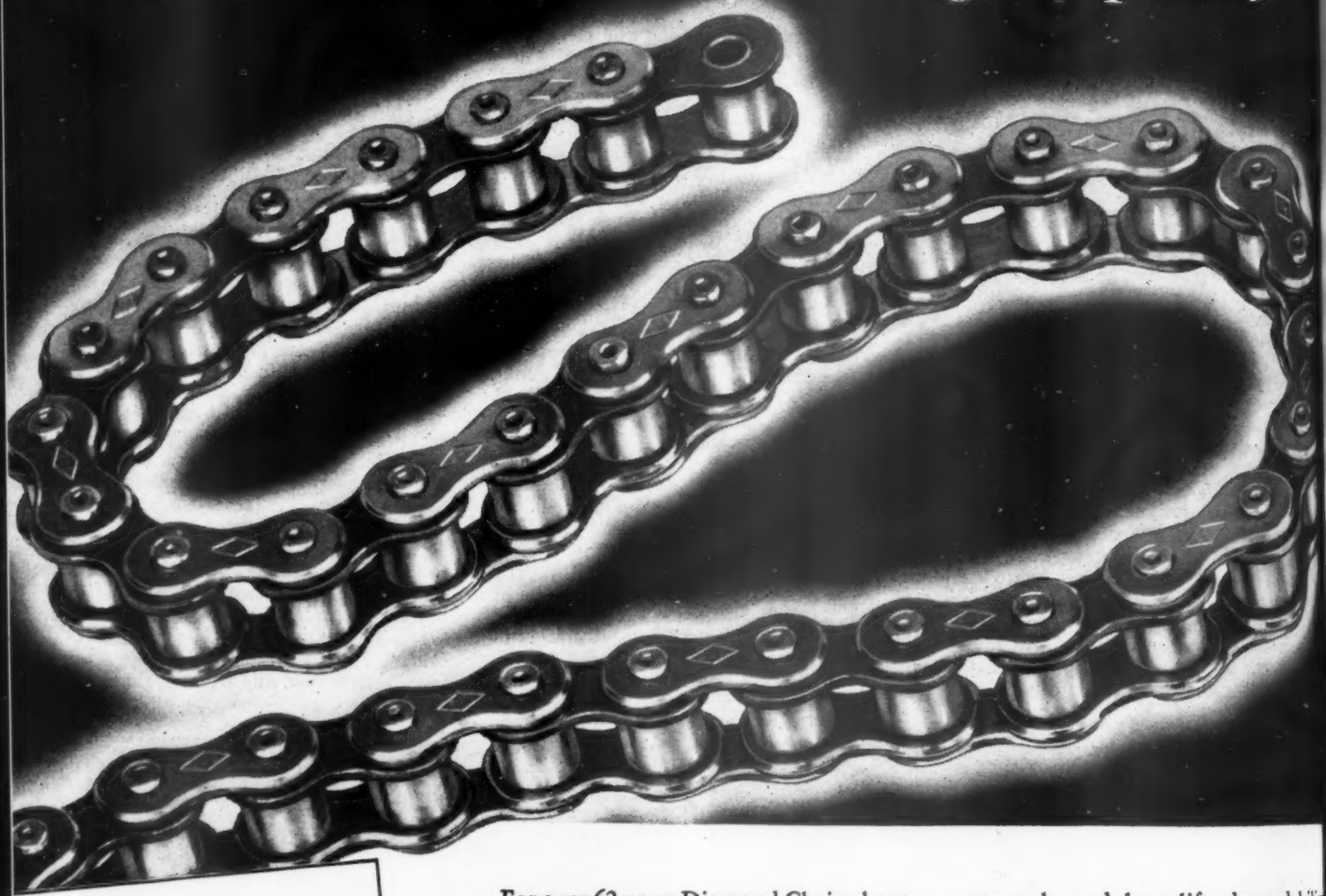

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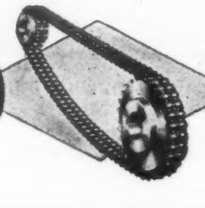

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feed was so great that depth of rolling was not controllable, and "spring" in various parts of the machine also interfered. Similar conditions were encountered in trying to roll in a thread miller with a roll mounted on the arbor. Apparently these machines could not carry or produce the necessary roll pressure to satisfactorily deform the metal at the thread root. Consequently, it became necessary to design a machine strong enough to roll threads and, at the same time, have enough rigidity to control the depth of rolling.

A self-contained unit, which uses a true surface of the collar as a supporting or back-up surface to carry the heavy load produced by the high work-roll pressure, appeared feasible. The only true surfaces available on a collar are those of the joint itself, such as the thread-crest cone or the shoulder face. The outside surface of the collar also is in alignment with the joint if the collar is carefully centered and aligned in the machine chucks when the threads are cut. With these elements in mind, the male thread rolling device of Fig. 8 was designed and built. It consists essentially of the two heavy side frames; two conical back-up rolls at the top with the same taper as the thread-crest cone; the work roll and its carriage, which are free to slide along a T-slotted wedge block than can be advanced or retracted with the calibrated micrometer screw at the lower right, thereby providing a vertical feed with considerable force applied to the work roll. Such a construction is rigid and with few parts to provide lost motion. The whole mechanism is held onto the drill collar by a flanged ring (clamped to the outside diameter of the collar with set screws), which engages a slotted half ring on the left side of the left frame. To place the machine on a collar, merely retract the work roll, pick up the machine, slide the half ring over the flanged ring, and let the assembly drop in place. The back-up rolls will then contact the thread-crest cone and the faces of their small ends will abut against the collar shoulder, thereby holding the device in alignment with the axis of the threads. Power for rolling is supplied by the machine in which the drill collar is mounted. The collar rotates inside the rolling device, which is blocked from turning with appropriate blocks on the bed of the lathe.

The flanged ring, which prevents lateral movements of the rolling device, must be aligned exactly with the drill collar shoulder face. The equipment for accomplishing this, Fig. 9, is composed of three rings; viz., the outer knurled ring, which engages the drill collar threads; a smaller split ring, which fits inside this ring and slides over the flange on the flanged ring, and the flanged ring, which carries the set screws for fastening it firmly to the drill collar. By tightening the knurled ring and split ring assembly firmly against the drill collar shoulder, the flanged ring is held in perfect alignment therewith. The set screws of the flanged ring, which slides loosely over the collar, then may be tightened firmly without regard to accurately cen-

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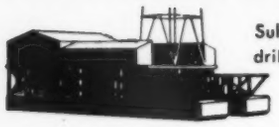

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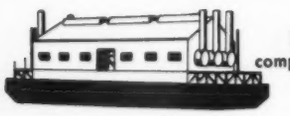

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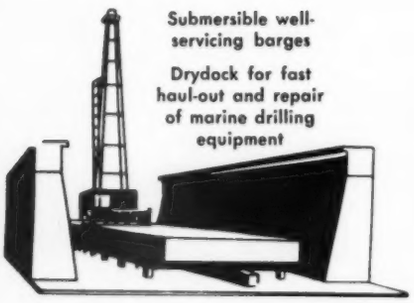

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tering this ring on the collar. Unscrewing the knurled ring will permit the split ring to drop off and the flanged ring is ready to accept the half ring of the rolling device.

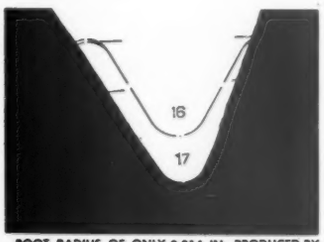
A box-thread rolling device that also uses the thread-crest cone surface for alignment and back-up was developed. The self-contained device, Fig. 10, mounted inside a cutaway section of a drill collar box consists of: a, the solid body cone with two hardened back-up shoes (one at top in contact with the threads); b, the roll carriage and work roll that slides in a T-slot in the cone; c, the heavy collar with set screws that holds the device onto the drill collar firmly against the drill collar face; d, the knurled, threaded, and calibrated ring that moves the cone into or out of the collar so as to produce radial feed to the work roll; and e, the square end shaft that drives the body cone in rotation so the work roll will follow the threads. Another view of the device, Fig. 11, shows it attached to a drill collar chucked in a large lathe to supply power for rolling. By blocking the cross-bar wrench placed on the square end of the drive shaft, the body cone can rotate relative to the drill collar as the drill collar turns slowly in the lathe.

If the threads on a drill collar are merely cut 0.010 in. shallow with a 60 deg, 0.020 in. radius truncated hob, and these are rolled 0.010 in. deeper by the use of a 60 deg, 0.020 in. truncated rolled, a thread form that is not 60 deg and does not have a root truncation of 0.020 in. will result. A thread form similar to the section shown in Fig. 12 is obtainable. A 55-deg thread is obtained because the metal on the thread flanks does not deform plastically, but the thread merely bends over then bends back as the roller passes through the adjacent thread. This bending back and forth takes place successively all the way down the joint leaving all threads of approximately 55 deg. The root of the thread is rolled 0.010 in. deeper producing a thread of full depth, but the bending of the thread flanks to 55 deg leaves the radius at the root of only 0.014 in. A 55 deg thread produces a false ring-gage standoff at the shoulder face, leaving the impression that rolling has caused a lengthening, or axial "growth" of the pin. If a pin thread rolled in this manner were made up into a standard 60 deg threaded box, flank contact of the threads woud not be obtained and the joint probably would wobble loose in a short time, resulting in early fatigue failure at the last-engaged thread of the pin.

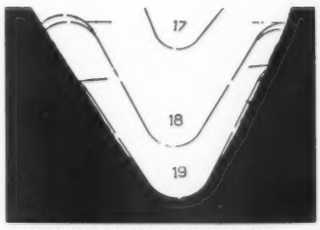
Inasmuch as it is desirable to roll threads with a 60 deg roller so that the thread flanks are wiped and burnished during the rolling process, and because there is no improvement in fatigue resistance to be gained by plastically rolling thread flanks, rolling of only the thread-root radius should produce a satisfactory thread form with the desired high fatigue resistance. Thread hobs were made with the teeth truncated to a radius of 0.030 in. Threads cut with such a hob and rolled 0.010 in. deeper with a 60 deg roller truncated to a radius of 0.020 in. produce a thread form as shown in Fig. 13. This thread form is the full 60-deg angle with the root truncation rolled to 0.020 in. A thread rolled in this manner checks correctly with thread gages and gives proper engagement on make-up.

Full-Size Fatigue Tests of Threaded Joints

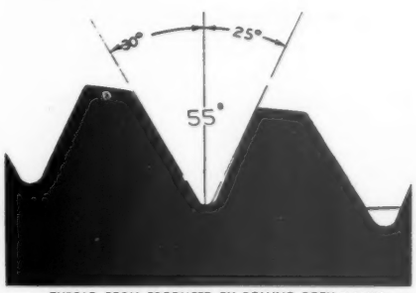
Full-size fatigue tests of threaded joints were made with various methods applied in an effort to improve the fatigue endurance limit of the made-up joint. The test bars were made from fully heat-treated and bored drill collar stock, the same as the previous test bars except in this case oversize stock was obtained and turned down for a short length adjacent to the threaded joint shoulder as



ROOT RADIUS OF ONLY 0.014 IN. PRODUCED BY ROLLING FLANKS AS WELL AS ROOT OF THREAD

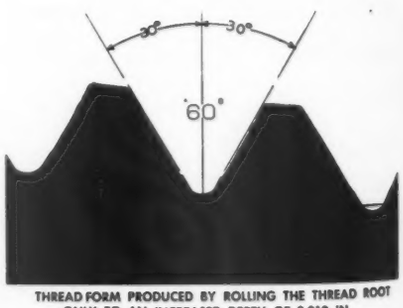


ROOT RADIUS OF 0.020 IN. PRODUCED WHEN THREAD ROOT ONLY IS ROLLED



THREAD FORM PRODUCED BY ROLLING BOTH FLANKS AND THREAD TO AN INCREASED DEPTH OF 0.010 IN.

FIG. 12.



THREAD FORM PRODUCED BY ROLLING THE THREAD ROOT ONLY TO AN INCREASED DEPTH OF 0.010 IN.

FIG. 13.

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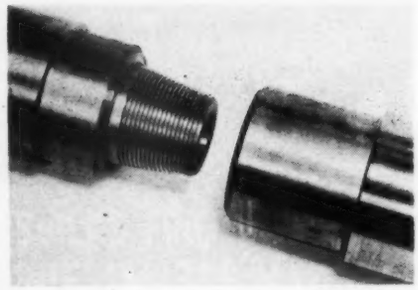

FIG. 14. Threaded ends of fatigue bar turned down to correct diameter at thread zones ready for bucking-up in torque machines.

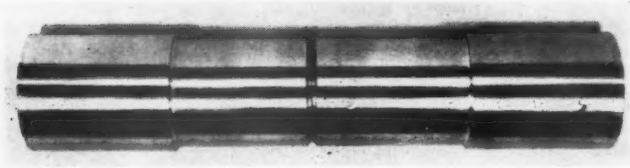

FIG. 15. Bucked-up and completely turned test bar ready for shrinking into fatigue machine adaptors.

shown in Fig. 14. This permitted the joints to be bucked up in a torque machine without undue shoulder interference because of the large diameter, and also gave plenty of space for gripping with the sharp jaws of the torque machine on the larger diameter. Later the jaw marks were turned off and the finished test bar of Fig. 15 obtained. An effort was made to buck up all test bars with a torque of 20,000 ft-lb so as to keep stresses in the joint and tightness as constant as possible. From the data accumulated on buck-up of these tests, the variation in circumferential advance from the so-called hand-tight position and also the variation of the box swelling are not an indication of joint tightness.

A number of full-size fatigue tests was made of joints treated according to the following methods so as to obtain a fairly good indication of the endurance limit from each treatment applied.

1. As hobbed (threads untreated).
2. Threads cold rolled 0.010 in. at root on pin member only.
3. Threads untreated, stress-relief groove cut in pin only.
4. Threads untreated, stress-relief groove cut in box only.
5. Threads untreated, stress-relief groove cut in both box and pin.

The term "stress-relief groove" means that a round-bottom groove was cut in the joint to a depth of 3/16 in. below the thread roots at the region of the last-engaged thread, which is well known as a stress concentrating point. In the pin member this groove was extended from the last engaged thread to the shoulder face and undercut it 1/32 in., so that the stress-concentrating corner between the shoulder face and the neck of the joint was removed. In this manner the sharpness of stress concentration at the last engaged thread and the stress concentration at the sharp corner the pin shoulder makes with the neck of the joint are reduced. A full view of a stress-relief groove in a pin before buck-up is shown in Fig. 16, 17, and Fig. 18 show sections of joints with stress-relief grooves in the pin and in the pin box, respectively.

The test data of the foregoing tests when plotted give the family of S-N curves of Fig. 19. The points on the curves are marked with a P or B indicating whether failure took place in the pin or box member of the joint. All failures were at the last engaged thread except those that carry a subscript u at the P or B. These failed through the stress-relief grooves of these tests.

Apparently the cold rolling of threads does not give as great an improvement in fatigue endurance limit as that found on the notched-bar tests, although tests of the joints with untreated threads give a limiting value comparable with the notched-bar tests. Several possibilities could be assumed for this apparent discrepancy, the most obvious of which is the tensile strength in the pin produced by buck-up.

The curves plotted from the tests of joints with stress-relief grooves indicate that cold rolling of threads in itself is not the most advantageous method of improving the fatigue endurance level of a threaded joint. Joints with a stress-relief groove in the pin show an endurance level of about 16,000 ft-lb, whereas cold-rolled pin joints show an endurance level at only 12,000 ft-lb. Compared with no treatment at all, cold rolling increases the endurance level about 50 per cent, whereas cutting a stress-relief groove in the pin raises the endurance level almost 100 per cent.

The test results on joints provided with stress-relief grooves indicate that a stress-relief groove situated in either pin or box or in both members contributes increased resistance to fatigue failure, although the improvement was greater with the groove in the pin alone than with the groove in the box alone. The improvement obtained with a stress-relief groove in both pin and box appears to be somewhat greater than that resulting from a groove in either the pin or the box only. In all cases, however, the improvement from stress-relief grooving was greater than that obtained by cold rolling the threads.

In consideration of the results obtained from the fatigue tests, it is to be remembered that fatigue curves, as drawn, are not meant to be a definite lines but the mean of a band obtained from the scatter of a large number of

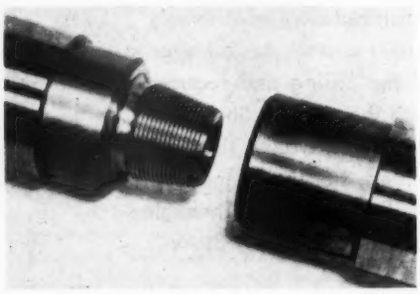

FIG. 16. Fatigue test bar with stress relief groove.

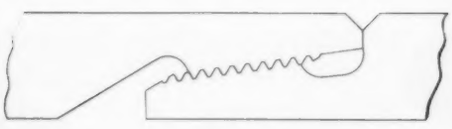

FIG. 16a. Diagram of stress relief grooves in box and pin.

FIG. 17. Section of fatigue test bar with stress relief groove on pin end only.

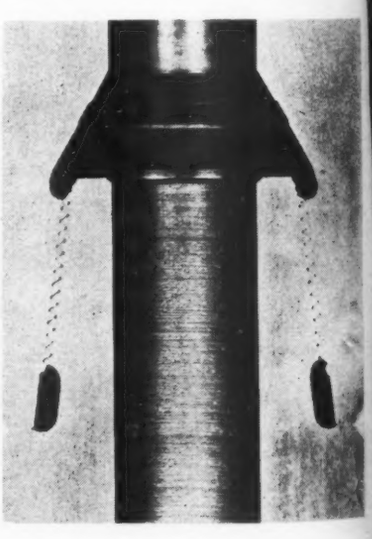

FIG. 18. Section of fatigue test bar with both box and pin stress relief grooves.

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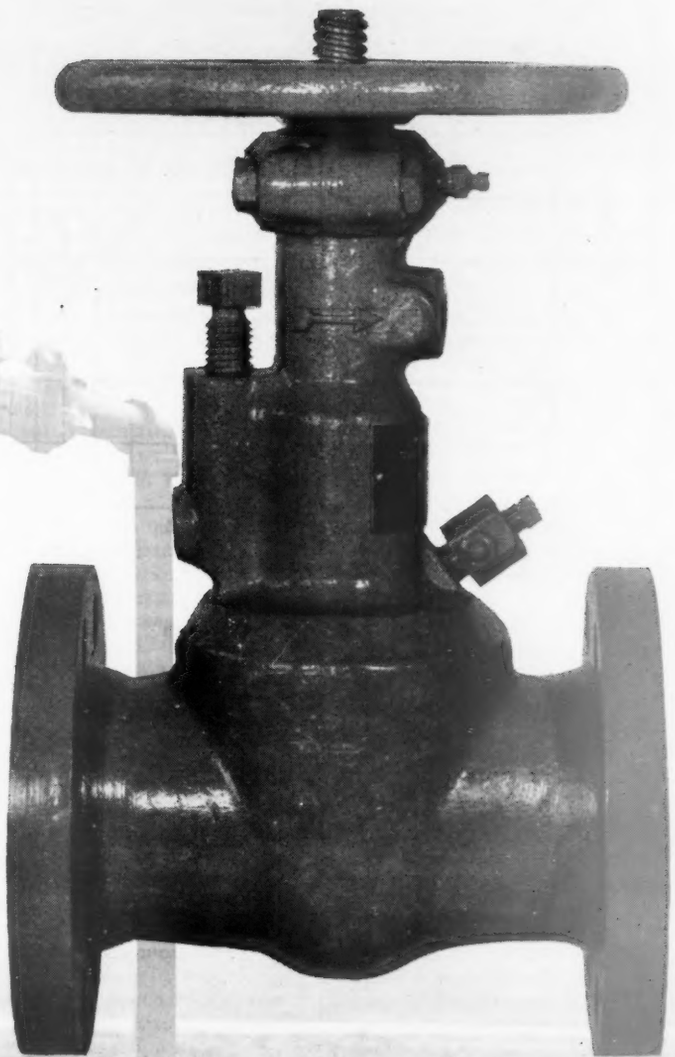

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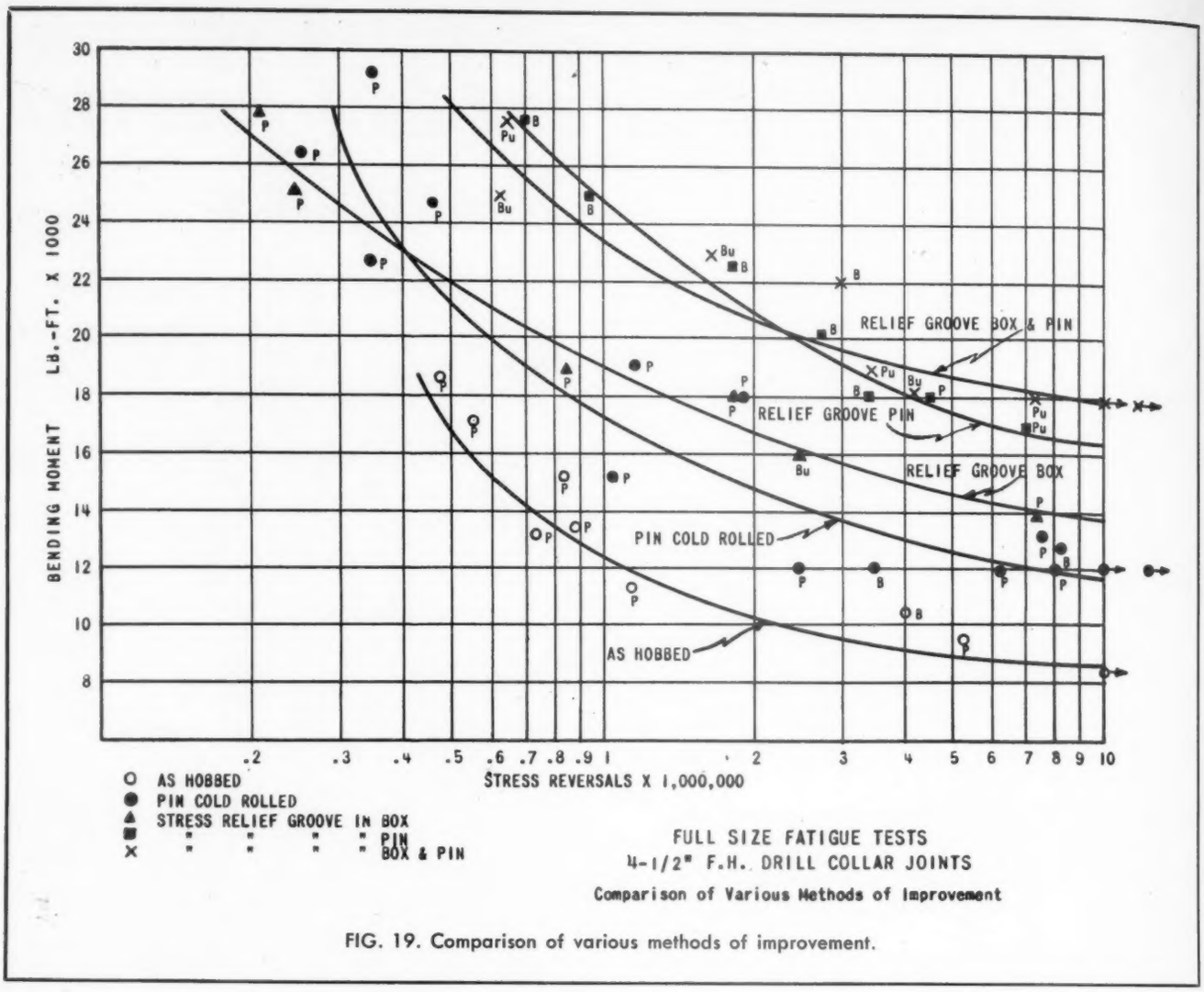
BENDING MOMENT Lb.-FT. X 1000
STRESS REVERSALS X 1,000,000
RELIEF GROOVE BOX & PIN
RELIEF GROOVE PIN
RELIEF GROOVE BOX
PIN COLD ROLLED
AS HOBBED
AS HOBBED
PIN COLD ROLLED
STRESS RELIEF GROOVE IN BOX
" " " " PIN
" " " " BOX & PIN
FULL SIZE FATIGUE TESTS
4-1/2" F.H. DRILL COLLAR JOINTS
Comparison of Various Methods of Improvement

FIG. 19. Comparison of various methods of improvement.

plotted points. This band is broad at the upper left where the stress loads are high, and tapers downward in a curved fashion to a narrow band at the right at the fatigue endurance level. This band might be considered as having a shape similar to the bowl of a calabash pipe. Therefore, the curves as plotted from the few tests made should indicate considerable overlapping at the left with a fairly good indication of the endurance levels at the right at the 10,000,000-cycle line. Even these may be subject to some error, however, but indications are believed to be good. To obtain a definite point on a true fatigue curve requires that at least five or six tests be made at one stress level and statistical methods applied to determine the optimum cycle value from the scatter of the data obtained. Obviously, time would not permit the making of such a large number of full-size fatigue tests even if the very accurate results warranted the expense.

It is well known that there is a high concentration of stress at the last engaged thread in any tightened threaded connection, whether it is a bolt, pipe thread, or drill collar thread. In a sharp "V" thread this stress concentration may be comparatively high and may be lessened by making a thread with a generous radius at the root. A still better way, which has been found to eliminate the stress concentration at the last engaged thread, is to cut a shallow circumferential groove with a generous round-bottom radius a few thousandths of an inch below the depth of the root of the last engaged thread. This causes an increased distribution of the stress and, consequently, improves the connection insofar as fatigue failure is concerned. A deep circumferential stress-relief groove that encompasses both the shoulder corner and the last engaged thread zone with generous radii apparently introduces some flexibility or other additional advantages which give surprisingly high fatigue endurance values. Just what depth of groove and degree of radius is required to produce the optimum in fatigue endurance for any particular size joint has not yet been determined. Further study is required.

The work reported here is only a beginning on fatigue studies that could be made on drill collar joints. Many other elements, such as relative proportions of pin and box members and thread details (such as form, pitch, and taper, etc.) remain to be investigated. In addition, the possibility of further improvement in fatigue strength by such measures as cold rolling the stress-relief groove either alone or in conjunction with cold rolling of the threads remains to be explored. It is believed that only full-size fatigue testing of joints can give reliable information on the contribution of these factors to the performance capacity of a joint. Such work, however, is time-consuming and rather expensive to perform; it has taken a little over three years to obtain the data accumulated in this report. It is presented here in the hope that it may be of value in its present form and might also encourage other organizations to contribute to the fund of knowledge in this field.

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★ ★ ★

AROUND THE WORLD

Venezuela. The Colon Development Company, Ltd., produced 499,259 bbl oil during the four weeks ending December 29, 1952.

Russia. Russia and satellites produced only 7 per cent of the world output. The remaining 93 per cent is produced by the free nations.

U. S. A. The United States produced 51 per cent of the total world oil during 1952, and Texas produced 33 per cent.

Middle East. This area accounted for 20 per cent of the world's 1952 production.

South America. Countries in this region continued to supply about 15 per cent of global crude.

Iran, Egypt, and Indo-China. Dr. Marlin M. Volz, Dean of the School of Law, University of Kansas City, stated that it is no mere coincidence that the trouble areas in the world are rich in oil. This statement was made in regards to the effect of the free nations' oil superiority upon world peace.

Guests of the Houston Nomads recently were: J. H. Grubb, National Supply, Caracas, Venezuela; E. P. Hayes, Cal-Tex Oil Company, New York City; Captain Carl J. Lamb, USN, Houston; W. Sumner, Socony-Vacuum, Cario; and J. G. Youngblood, Texas Petroleum Company, Bogota, Colombia. Also present but not in the picture was W. G. Harlan, Creole Petroleum, Caracas, and E. A. Miller, Reed Roller Bit Company, Oklahoma City. Principal speaker was Capt. Lamb who gave the story of naval procurement.

TEXAS

• It may be possible in the near future to increase production by the application of bacteria in the well bore. A. J. Krell, technical director of Reliance Chemicals Corporation, Houston, is planning to undertake a special study.

It is thought that under certain rapid producing conditions the inherent microorganisms and their entire systems may be wasted by being withdrawn from the reservoir. The idea would be to introduce specially prepared bacteria into the producing formation and so make up the natural deficiency, and thereby restore oil production.

According to reports a major oil operator contemplates the use of wells for such a study in the Gulf Coast area.

• Texas oil fields accounted for 45 per cent of the nation's output during 1952. The daily average was 2,815,900 bbl. Texas production exceeds the whole Middle East by 700,000 bbl per day, 300,000 bbl per day more than the Western Hemisphere, and twice as great as Russia and her dominated countries.

The number of producing wells at the beginning of 1953 is 139,629, which shows an increase of 7162 over 1951. New fields increased by 570 to make a total of 7162 for the state of Texas.

• Magnolia has extended the Parks pool in Midland County, West Texas, by ¼ mile to the southwest. Well was perforated at 10,568-78 ft and has 17/64-in. choke. Also in the same county Plymouth Oil Company brought in the second well in the Hallanan pool (Strawn) with 566 bbl of 49.9 gravity oil on a ⅜-in. choke. Producing interval, flowing, is 10,640-46 ft.

• Stanolind Oil and Gas Company had an important find when a step-out in the Wellman field, Terry County, Texas, flowed 210 bbl oil, 26/64-in. choke, from 9865-84 and 9890-900 ft.

• Phillips Petroleum Company has discovered a new deep producing zone that promises to increase substantially the already large gas reserves in the Chocolate Bayou field, Brazoria County, Texas. The well is the Schneck 2-A, and is perforated at 13,945-50 ft in the basal portion of the lower Frio sand, which is at 13,901-49. Production rates as high as 22,000,000 cu ft of gas per day were obtained and also considerable condensate content. Total pressure closed in was 9530 psi.

MIDDLE EAST

• Crude oil production in Saudi Arabia during December was 22,716,838 bbl oil, an average of 732,801 bbl per calendar day. Production for 1952 averaged 824,756 bbl per day.

• Kuwait is the second largest producer in the Middle East. The estimated daily production for 1952 is 752,000 bbl.

Annual meeting for election and installation of officers of 1953, New York Chapter of Nomads.

News

CANADA

• Ole Berg, Jr., president, British American Producing Company, Toronto, together with G. Godsoe, Jr., visited the Dallas offices of their company recently. It was the first visit of the president to the new head offices. They were previously in Tulsa, Oklahoma. C. D. Miller is vice president of the company in Dallas.

• W. D. C. Mackenzie, manager Western Division, Imperial Oil Ltd., stated at the AIME meeting in Duluth that an expanded Canadian oil exploration program could result in at least 25 billion barrels of oil being found before the end of the century. Mackenzie placed the present reserves between 1.7 and two billion barrels, 23 times that of 1946.

OKLAHOMA

• Vickers Petroleum Company has brought in a wildcat oil well, Vickers Ferguson No. 1, in an extension of the Eola field of Garvin County, Oklahoma. Sohio's Henthorne well is approximately one mile southeast of the Vicker's strike. Vickers' new producer flowed 809 bbl through a 20/64-in. choke the first 39 hours. Total depth of the well is 10,987 ft. Casing was set at 10,462 ft and perforated at 10,446 to 10,460 ft. These sections were drillstem tested separately. On the first test the well flowed 15-20 bbl of 40 gravity oil per hour. On the second test the well flowed 20-25 bbl of 38 gravity oil per hour. Area is surrounded by Stanolind, Sohio and Texas Pacific Coal and Oil.

AAPG ANNUAL MEETING

L. F. McCollum, president of Continental Oil Company will be featured speaker at the third annual meeting of the Rocky Mountain Section of the American Association of Petroleum Geologists to be held in Casper, Wyoming, April 22-24. More than 1500 members of the association and their guests are expected to attend the session, first to be held in Casper.

In addition to the keynote speaker, program will include discussions of the various prospective and productive areas of the Rockies by speakers recognized as authorities on the specific areas. Nearly a full day will be devoted to a discussion of the various aspects of the Williston basin in the United States and Canada, with individual treatment given to most of the discoveries made to date in the basin.

Denver-Julesburg basin, basins of Wyoming, Four Corners region in the Utah-Colorado-New Mexico-Arizona corner area, southeastern Colorado region, and special characteristics of more localized areas will be discussed in a series of non-statistical technical papers.

One geological aspect of the Rocky Mountain region will be treated by V. E. McKelvey, chief of the trace elements section of the United States Geological Survey, Washington, D. C., who will discuss the search for radioactive materials in the Rocky Mountain region.

Registration will begin on April 22, and the convention will be concluded with the annual dinner and dance on Friday evening, April 24. Housing may be arranged with J. F. Partridge, P. O. Box 1772, Casper.

WILLISTON BASIN

• Development operations for oil cost $75,000,000 in North Dakota in 1952, and about 1,500,000 bbl oil was produced during the year. Total number of wells in this area is 90.

Amerada has an investment of some $20,000,000 in North Dakota and will invest in all probability another $15,000,000 in 1953.

• Three new pools were produced in 1952, Hofflund, Charlson, and Croff. Production characteristics of these fields did not equal those of the Tioga discovery in 1951. North Dakota has three major producing zones, Madison, Devonian, and Silurian, with the Madison as the main reservoir.

ROCKY MOUNTAIN

• Nearly $43,000,000 was spent on leases, exploration, and development in the Rocky Mountain region in 1952. Records were set in almost all phases during that year.

• J. H. Barnett has resigned as Rocky Mountain division engineer for Stanolind Oil and Gas Company to open an office as a petroleum consultant with headquarters in Casper, Wyoming. He plans to specialize in appraisals, evaluations, unitization plans, and management of oil and gas properties throughout the Rocky Mountain region.

Barnett graduated from the University of Colorado in 1933.

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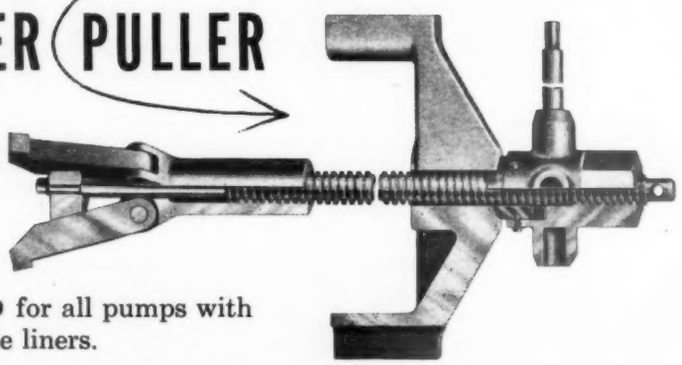

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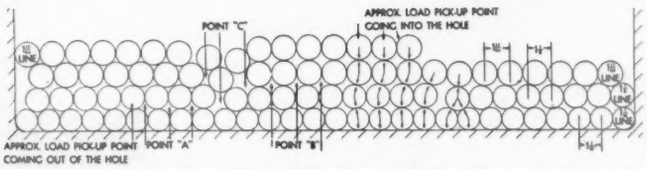
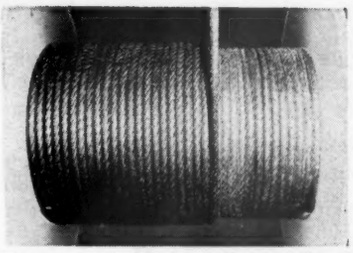
PAGES FROM THE LEBUS WIRE LINE SPOOLING HANDBOOK

PROGRESSIVE GROOVING

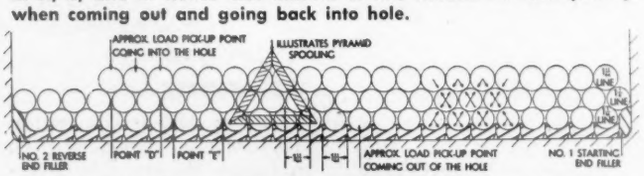
Eliminates WIRE LINE CUTTING IN!



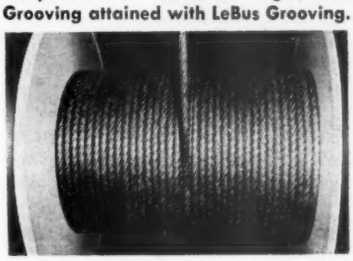
Above is an illustration of the plain drum spooling of a worn, tapered or stretched 1 1/8" wire line. Notice gaps, slipping over and cutting in at A, B, and C. Notice also amount of line needed for load pick-up when coming out and going back into hole.



These two photos show the second and third layers of line being spooled on parallel side of LeBus Grooved Drum. They further illustrate Progressive Grooving attained with LeBus Grooving.


APPROX. LOAD PICK-UP POINT COMING INTO THE HOLE
ILLUSTRATES PYRAMID SPOOLING
NO. 2 REVERSE END FILLER
POINT "D"
POINT "E"
APPROX. LOAD PICK-UP POINT COMING OUT OF THE HOLE
NO. 1 STARTING END FILLER

Above is a LeBus grooved drum with the same worn, tapered or stretched 1 1/8" wire line. NO GAPS, NO SLIP-OVER, NO CUTTING IN. NOTICE that less line is required for load pick-up when coming out or going back into hole.



In the past, one of the greatest sources of trouble in wire line spooling has been the wire line CUTTING IN. This is due principally to the haphazard or uncertain line action of helical spooling. With helical spooling, it is difficult to prevent worn line from slipping over while lifting excessively heavy loads. Under the new LeBus System of Controlled Pyramid Spooling where 75% to 85% of the wire line forms grooves for the succeeding wraps (illustrated by diagrams above and photos to left), we accomplish what is called PROGRESSIVE GROOVING with 75% to 85% of each layer of wire line wraps. By this method, CUTTING IN can be eliminated, since each layer of wire line is held in grooves formed by the preceding layer of wraps.

Regardless of speed used in your hoisting operation, with Progressive Grooving, there is a minimum of possibility for line to crowd over, or slip over out of the line grooves and allow CUTTING IN on the first, second, third, fourth, fifth or any number of layers of wraps; that is, unless the operator becomes careless as to EXCESSIVE line wear, the traveling block, hook and elevator being TOO LIGHT, or the line being spooled too loosely on the drum. Mechanically, the maximum of true Progressive Grooving and Pyramid Spooling is obtained with the LeBus Grooving and Controlled Pyramid Spooling System.*

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What's Doing in Drilling

MISSISSIPPI

• Gulf Refining Company has a new deep pay that produces a high gravity oil in the Baxterville field, Lamar County. The well was drilled to 13,431 ft and due to a fishing operation a plug back to 9700 ft was necessary. The final depth was 10,880 ft. The present productive zone is new and is at approximately 10,821 ft.

• Marshall R. Young has drilled No. 1 S. J. Farmer in West Lincoln field, Lincoln County, to a total depth of 10,624 ft. The production is from the Glen Rose at 10,576-86 ft. Initial flow rate was 230 bbl oil per day on a 12/64-in. top choke and ¼-in. bottom.

ALABAMA

• Humble Oil and Refining Company completed No. 5 A. W. Moye in the Pollard field, Escambia County. The well flowed at 126 bbl per day and has a gravity of 26.1. Total depth of well was 6190 ft and was perforated opposite the Massive sand at 6111-17 ft.

ILLINOIS

• Twenty-two members of the Continental Supply Company met recently at the Quincy, Illinois, plant of Gardner-Denver. A discussion on the latest mud pump developments was held. The study groups consisted of Continental Supply executives and district managers, and Gardner-Denver officials and mud pump engineers.

Great interest was shown in the special feature of the newest Gardner-Denver pump that simplifies a problem in stocking spare parts. The liquid cylinders on these pumps are fully interchangeable, and one spare fluid cylinder, either cast steel or alloy, will fit either the right or left hand side of either the 16-in. or 18-in. pump.

Rotary Rigs Operating in Oil Fields of United States and Canada*

Weeks	Total	Gulf Coast	Pacific Coast	Illinois Oklahoma Kansas	Rocky Mountain Canada	West Texas New Mexico	Arkansas Texas Louisiana	North Texas
(December)								
Third	3032	669	182	725	420	532	152	352
Fourth	2801	649	179	631	387	483	146	326
(January)								
First	2775	633	180	616	398	480	139	329

*As reported to the American Association of Oil Well Drilling Contractors by the Hughes Tool Company.

NEW MEXICO

• A probable new pay zone and a south extension for the Saunders pool in Lea County was indicated by a drillstem test at Cities Service Oil Company's State AG No. 1. In a two hour test 1050 ft of high gravity oil was recovered from the Wolfcamp limestone at 9560-9602 ft. This is above the Saunders limestone pay, from which other pool wells produce.

OKLAHOMA

• Johnny Mitchell is testing his No. 1 Boedecker in Northwest Evansville field in Logan County, Oklahoma. The well was taken to 5779 ft and has perforated top 2½ ft of the Wilcox at 5774-76½ ft. Following initial flow-tests, production was pinched to 10 bbl per hour through 7/64-in. choke, with 225 lb of on tubing and 725 lb on casing, the company has reported.

• Cummings-McIntyre has a new well in the East Pond Creek pool in Grant County. The well flowed 74 bbl of oil in 2 hr through 11/32-in. choke. It was bottomed at 5934 ft.

• Sohio Petroleum Company conducted a drillstem test on Harrell No. 2, Eola field, Garvin County. The interval tested was 7233-90 ft and 20 bbl oil flowed per hour from the Hunton lime.

UTAH

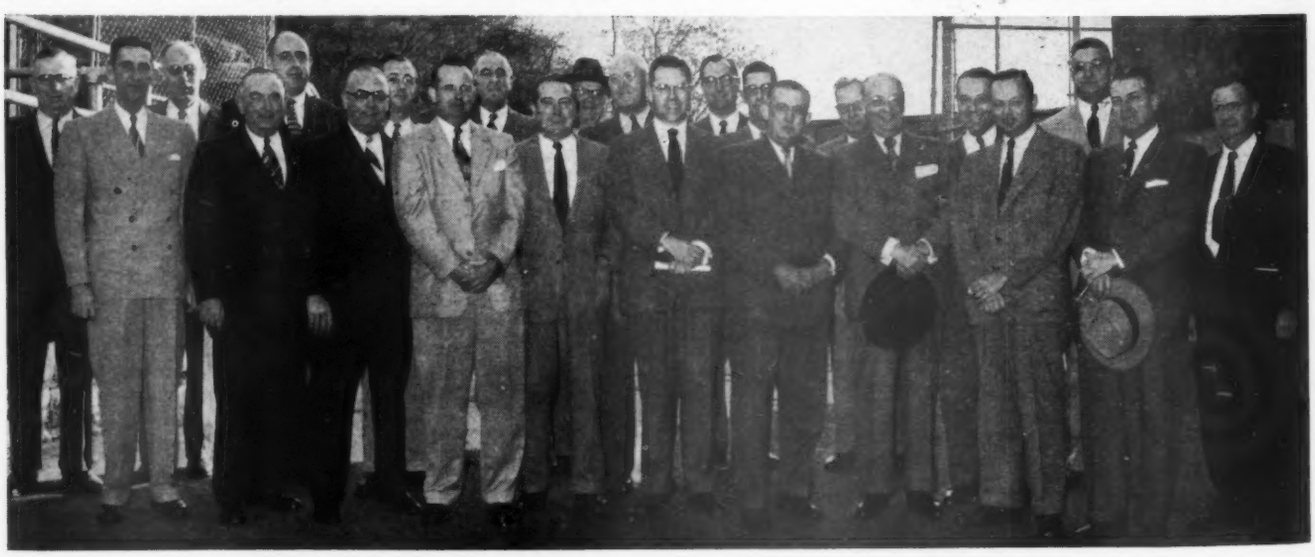
• Clear Creek gas reserve has been extended by about 2 miles in Carbon County. Three States Natural Gas Company are the owners of the well, and McConnell Drilling is the contractor. Another well is now in progress of being drilled for the company by McConnell near Price.

TEXAS

• Drilling operations are sensitive barometers in the oil picture, and in 1952 Texas drilled 1000 wells less than the number originally forecast a year earlier. Oil men drilled 17,099 holes, a new record, but only 88 more than the previous year. A dampening effect on drilling apparently came from curtailment in the Spraberry trend area in West Texas, where high well costs and low recovery rates were proving a disappointment.

This situation with general high costs and steel shortages was further aggravated by the fact that although more wells were drilled, 487 fewer were completed as oil or gas producers.

Approximately $3 billion entered Texas business arteries as a return on the sale of crude oil. Also some $705,000,000 was added to the value by transportation and manufacturing processes.



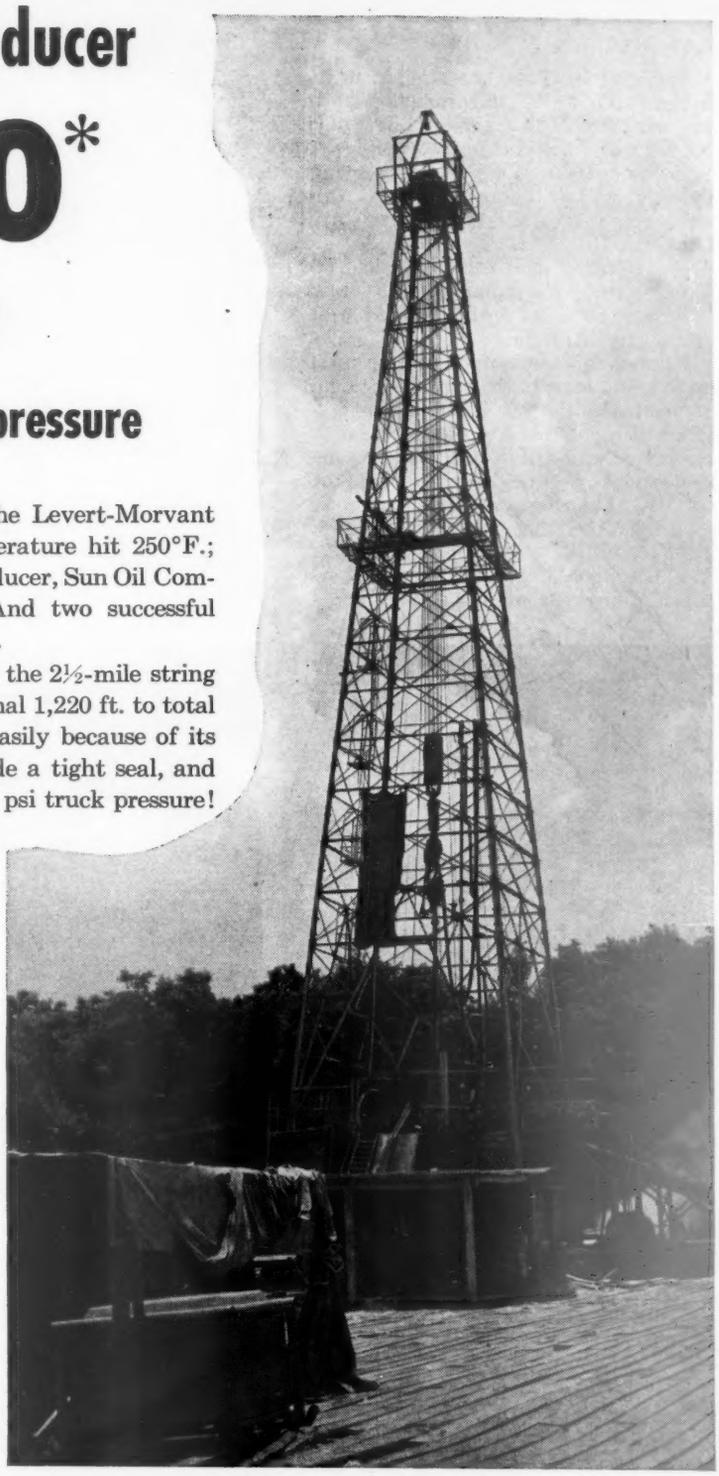
Executives and district managers of Continental Supply are shown with Gardner-Denver officials and mud pump engineers when they met to discuss latest mud pump developments. The group met at the Quincy, Illinois, plant of Gardner-Denver.

In their deepest producer

UNAFLO*

pumped easily

despite extreme heat and pressure



Down 14,506 ft. in Louisiana's Chacahoula field, the Levert-Morvant No. 2 ran into severe cementing conditions. Temperature hit 250°F.; bottom hole pressure, 9500 psi! For their deepest producer, Sun Oil Company chose dependable Unaflo Oil-Well Cement. And two successful cementing jobs—casing and liner—proved them right.

In just 90 minutes, Unaflo went in place around the 2½-mile string of 7″ casing. Then a 5″ liner was cemented an additional 1,220 ft. to total depth. Despite heat and pressure, Unaflo pumped easily because of its retarded set. A squeeze was not needed. Unaflo made a tight seal, and the formation did not break down, even under 4,800 psi truck pressure!

Whether your next job is hot and deep, or a routine cementing operation where delays *could* crop up, you can rely on Unaflo 3-way protection!

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HARDENS NORMALLY—Unaflo, after its retarded period, makes a strong, tight seal—resistant to sulfate waters.

Helpful free bulletin gives facts-and-figures comparison of Unaflo's well-bottom performance with that of other cements. For your copy write: Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Avenue, New York 17, N. Y.

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Drilling

CANADA

• Imperial Oil Ltd., has brought in its Bitten Lake well. The producing horizon is the Cretaceous. Imperial has some 7000 acres in the area.

In accordance with the agreement, Imperial will drill four deep tests. Offset acreage is owned largely by North Canadian Oils, Ltd.

• Shell drilled stem tested and had oil shows in their Westerdale foothills well. It is some 50 miles north and just west of Calgary, Alberta.

• Various sub-committees have been set up to study some of the various accident prevention problems. These subcommittees will report back to the main safety committee who will in turn make recommendations to the directors of the CAODC. The sub-committees that were set up and their members are as follows:

Safety Films and Visual Training: A. E. Grainger, McIvor Drilling, W. Laybourn, University of Alberta.

First Aid and Trophy Committee: J. Muir, General Petroleums, A. E. Grainger, McIvor Drilling, George Davis, Halliburton, H. Whitworth, Mines Safety Appliances.

Drillers Safety Award Committee: K. Tipps, Brinkerhoff Drilling, B. Holbrook, Canadian Gulf.

Driver Training Committee: H. Jackson, University of Alberta, J. Muir, General Petroleums, and D. L. Cuthbert, Imperial Oil.

Safety Color Code for Drilling Rigs: Paul Bassett, Regent Drilling, and Neil Goertz, Can-Tex Drilling.

Hydrogen Sulfide Publicity: D. Cuthbert, Imperial Oil, and Gordon Cochran, Arrow, Canbridge, Trident.

CAODC Monthly Publication: Ken Tipps, Brinkerhoff Drilling.

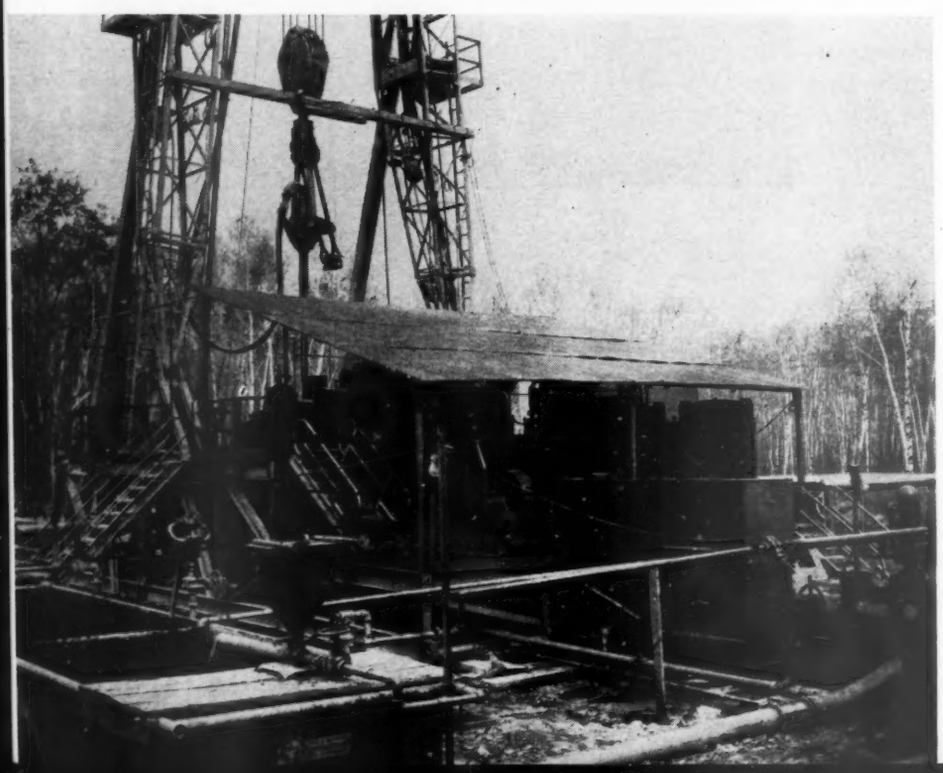
Rig Inspection Sheet: W. Laybourn, University of Alberta; A. Grainger, McIvor Drilling, and J. Muir, General Petroleums.

DRILLING ROUNDUP

Venezuela. Pantepec Oil Company has recently drilled a well as a step-out in the El Roble concession No. 30 in eastern Venezuela. Two producing zones occur, one at 6100 ft and the other at 6750 ft. The initial flow was 517 bbl per day on a 21/64-in. choke.

Washington. Petroleum Administration for Defense (PAD) requested from The National Petroleum Council a report on petroleum productive capacity as of January 1, 1953. The report says: "The rate of drilling is related directly and primarily to economic factors, including but not limited to: a) relationship of petroleum supply and demand; b) income available from production, which depends on both the level of production and the price received; c) average cost per well; d) fraction of available income that will be spent for wells; e) effects of taxes; f) effects of inflation or deflation in the general economy."

Drilling in Driftwood field, near Renovo, Pennsylvania is a Keta Oil and Gas Company rotary rig. Driller, upper left, is at controls; upper right, a length of drill string is being added. Below, a side view shows mud tanks at left.



PENNSYLVANIA

• An "invasion" of Pennsylvania by rotary drilling rigs is being watched with interest by oil and gas drillers. The event is significant because the Eastern United States is considered a cable tool area, and Eastern drillers have preferred the cable tool for getting through the hard rock formations in the region.

Seven rotaries are drilling for natural gas near Renovo, Pennsylvania. In some cases the two methods are teaming up, with the cable tools used to penetrate the hard top down to 3000 ft. and then the rotary is utilized for drilling to 7000 ft. Sometimes the rotaries drill the complete well.

Delta Drilling Company has 3 rotaries operating in the area. The largest rotary rig in the Pennsylvanian fields is operated by Keta Oil and Gas Company. It is a National Supply Ideal Type 75CB and J. H. Minyard of Midland, Texas, is the toolpusher. The first well drilled with the outfit brought in a 1,500,000 cu ft gas well. The drilling time to a total depth of 7034 ft was 31 days.

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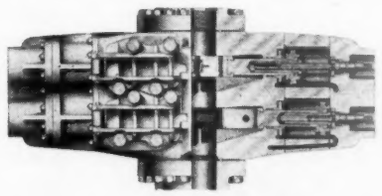
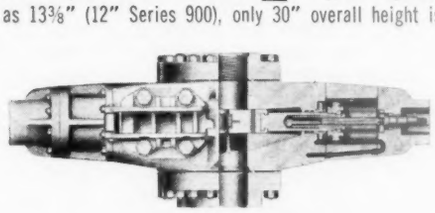
Hydraulic

OPERATION

In these Gates, rams are opened and closed by hydraulic fluid under pressure. Their operating speed, convenience and quick adaptability to various hook-ups make Shaffer Hydraulic Gates ideal for a wide range of modern drilling applications.



The Shaffer Hydraulic Double Cellar Control Gates provide two individually-operated ram compartments unitized into one compact body. Even in sizes as large as 13⅜" (12" Series 900), only 30" overall height is required.



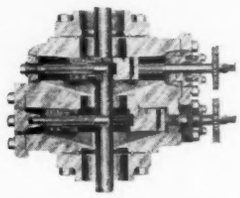
The Shaffer Hydraulic Single Cellar Control Gates may be used singly, or with other Single or Double Hydraulic Gates, to provide one or more ram compartments to meet various operating requirements. This gate requires only 18½" overall height in sizes as large as 13⅜" (12" Series 900).

Both Double and Single Hydraulic Gates provide:—Unmatched simplicity in changing rams by merely opening doors in the gate body . . . completely enclosed design with no exposed moving parts . . . self-draining compartment bottoms . . . direct hydraulic drive without yokes or secondary connections . . . and many other exclusive advantages.

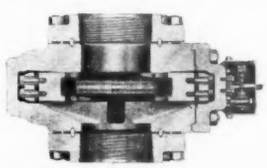
Mechanical

OPERATION

In these Gates rams are opened and closed by synchronized operating screws rotated by a compact motor drive—or manually. Simple and compact, Shaffer Mechanical Gates are very easy to install and are preferred by many operators for certain types of operations.



The Shaffer Mechanical Double Cellar Control Gates provide two separate ram compartments unitized into one compact body. Even sizes as large as 13⅜" (12" Series 900) these Gates require only 28½" overall height.



The Shaffer Mechanical Single Cellar Control Gates may be used singly or with other Single or Double Mechanical Gates to provide one or more ram compartments, as required. Need only 17⅜" overall height even in sizes as large as 13⅜" (12" Series 900).

In both Double and Single Mechanical Gates, rams can be changed by removing only one end cover . . . compartment bottoms are self-draining . . . well pressure is used to assist the sealing operation . . . and there are many other advantages.

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XUM

Exploration Activities

KANSAS

• In Cowley County, Absher and Booth brought in an initial producer of 3000 bbl per day. Production is from the Bartlesville sand bottomed at 3270 ft, and the well is in the Northwest Harvey field. Also in the same county and from the same sand, the McKay field No. 3 Klink A, Smitherman-Cohen, was completed for 1246 bbl per day. Bartlesville sand is bottomed at 3331 ft in this well.

• A wildcat well in Ford County has good gas shows from the Mississippian, top of which is at 5016 ft. Casing is cemented at 5059 ft and the well is scheduled for testing. M. B. Armer is the operator, and the new discovery is some 20 miles west of the Brenham field.

NEW MEXICO

• Skelly Oil Company has a new oil pool in Lea County, New Mexico, at its No. 1 Mexico R. On drillstem test between 10,687-740 ft, with tool open 6 hr and 20 min, gas showed in 16 min, and the well flowed 128 bbl of oil in 5 hr with 1,156,000 cu ft of gas a day. Total depth of the well is 10,765 ft, and 5½-in. casing was set on bottom.

CALIFORNIA

• For the last 5 years International Geophysics Inc., Los Angeles, has been perfecting a play back technique that appears to offer a valuable aid in the study of frequency components of seismic waves. Cooperating in that portion of the research work that was done in the United States were Signal Oil and Gas Company and Continental Company, and in Canada, Tide Water Associated Oil Company, Ohio Oil Company, Columbia Carbon Company, and Atlantic Refining Company. The time saved in computation and interpretation more than offsets the play-back time, and the play back technique can be, and is an effective tool for successful seismic mapping in so called marginal areas.

ROCKY MOUNTAIN

• Increased geophysical activity is the most striking development in the Rocky Mountain area during 1952. More than half the work was done in Montana and the Dakotas as part of the intensive campaign of evaluation of large Williston Basin holdings of many operators. This area alone had 6240 crew weeks of geophysical exploration as compared with 6161 crew weeks for the entire region in 1951.

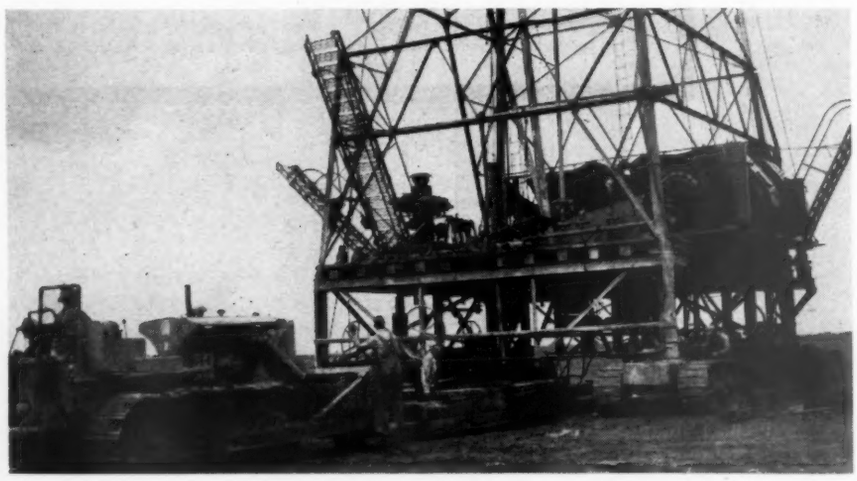
Estimated cost of new leases of all types, and carrying costs of land already under lease for the entire region was $92,500,000, an all time high.

The oil industry invested an estimated $430,000,000 in the future of the Rocky Mountain region in 1952. This figure is only the dollars that were spent in acquiring and carrying leases, in geophysical exploration, and in development and wildcat drilling.

During the past two or three years it is apparent that more and more companies are moving into the region. The 250 active geophysical parties in the Rocky Mountain region constitute more than 25 per cent of the entire number available in the nation.

Considering the large areas to be covered in Montana and the Dakotas the geophysical work there may be expected to continue at an intensive level with detailed studies expected in many portions of the basin. The interpretation of shooting picture data in a considerable portion of the Williston Basin is a difficult task. Additional drilling will perhaps clarify some of the existing confusion and inability to correlate.

• Union Oil Company is completing its No. 24-T No. 3 in Montana, and indications are it is one of the largest gas wells ever finished in the area northeast of the Cut Bank field and east of the Darling pool. It was drilled to 2595, where flow of gas is estimated at 30,000,000 cu ft daily.



Oil and gas rig moving. Heard and Heard, Inc., of Refugio, Texas, use Caterpillar diesel D8 tractor equipped with No. 8S bulldozer and Hyster winch to move oil rig mounted on Athey tracks.

LOUISIANA

• A joint venture of Texas Gulf Producing Company and Pan American Production Company has resulted in a successful step out completion in the parish of Assumption. The well is Babin No. 1 in the Napoleonville area and was tested from 10,308 to 10,318 ft. Initial flowing production was 295 bbl oil per day with a gravity of 36.5, choke 10/64.

• A new producing area known as the Rifle Point field has been opened in Concordia Parish. Barnett Serio et al brought in the Learner No. 1, Wilcox, at the rate of 132 bbl per day through 13/64-in. choke. The perforated interval is 4031-35 ft. Gravity is 44.5.

• A new well has been brought in in Terrebonne Parish, Louisiana, 10 miles from nearest production. It is The Texas Company's Bay Junop 3-2, jointly owned with Union Oil of California, which was completed as a gas well and shut in with a tubing pressure of 4400 lb. Gas-oil ratio was 65,731 to 1. The well was reported flowing at a daily rate of 63 bbl of oil through a ¼-inch choke on the initial test. Total depth was 13,512 ft, with perforations made from 12,666 to 12,682 ft.

TEXAS

• Lion Oil Company announced the completion of its Mary No. 1 well in Coke County, Texas. Total depth was 5673 ft with perforations at 5310-42 ft. The initial flowing production was 867 bbl per day, choke 16/64, gravity 50, GOR 111. Lion has considerable holdings in the immediate vicinity. Two other wells are being drilled in the area by the company. Several zones of potential oil production were found in the well and have been tested. Dual completions may be called for later.

• Production tests at three important West Texas wells operated by Cities Service Oil Company provided an important oil flow at Cross B No. 1 wildcat in Glassrock County; discovery of a new pool at Starnes D No. 1 in Terry County, and an extension to the Clara Couch pool in Crockett County at Hobbs B No. 1.

• Texas Gulf Producing Company made a drillstem test and recovered oil on its rank wildcat, Headlee No. 1 in Ector County, Texas. In a 90-min test 23 bbl oil were recovered, gravity 52. An open hole section from 13,106 to 13,166 ft was under test. Well is to be drilled deeper into the Ellenburger, of which only some 60 ft has been penetrated. Final depth will probably be 14,000 ft.

• Midland County, Texas, is the scene of a new oil well brought in by Plymouth Oil Company. The well is the Foster 1-B in the new Hallanan-Strawn field, came in with an initial 24-hour production of 567 bbl of 49.9 gravity oil through a ⅜-in. choke. Gas-oil ratio was 1480 to 1. Producing depth was between 10,640 and 10,646 ft in the Strawn section.

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Exploration Activities

OKLAHOMA

• Of over 200 completions in Elk City field the average drilling time for 10,000-ft wells has been 41 days. Helmerich and Payne, the drilling contractors, have just completed Fender D-3 in 30 days for the Shell Oil Company in that field. Toolpusher was Wesley Reed and drillers were Jean Barton, Guy Robinette, and E. L. Shelton. Three 12½-in. rock bits and 48, 7⅞-in. were used. The rig was an Oil Well 96. The previous record was 32 days and this was done by the same contractor using a National 80 rig. The speed and success of the new record was attributed to personnel efficiency.

• Logan County in the center of Oklahoma is now an exploratory "hot spot" in the state. D. F. O'Rourke and Sunray Oil Corporation have also had a discovery in the area. Theirs is the Ferguson Estate No. 1, which is north of the Northwest Evansville pool. Perforations are at 5249-5256 ft and swabbing has realized a production of 42 bbl of 44 gravity oil.

• A deep test in Logan County may lead to an important discovery. The wildcat is south of the West Navia field and northeast of the West Edmond pool. The well is the Krout No. 1, Blackwood and Nichols Company and Macmillan Petroleum et al. The formation test in the Second Wilcox yielded 100 bbl oil per hour. Gravity is 41.5. The hole is presently bottomed at 6520 ft. It is anticipated to core ahead in the Second Wilcox.

Helmerich and Payne record-breaking drilling crew includes: Edwin Prikryl, J. F. Gabbard, James Kenney, R. E. Hawkins, J. A. Willoughby, Jack Shelton, Douglas Sipes, Guy Robinett, Arthur Jennings.

WILLISTON BASIN

• An Ordovician producer, Government McGee No. 1, has been completed by The Texas Company in the Glendive area in Dawson County, Montana. Flowing production was 236 bbl oil per day from perforations at 9957-10,073 ft.

• The Tioga field in North Dakota, operated by Amerada Petroleum Corporation was extended by half a mile when the Arnold Blikre No. 1 in Mountrail County was completed successfully. The well flowed 499 bbl oil per day, gravity 42.8, and 540,000 cu ft gas. The Madison lime had an acid treatment through perforations at 8141-80 ft.

ILLINOIS

• Semi-wildcats in Washington and White counties are under keen observation. E. A. Obering's Hasemeier No. 2 had a flowing production of 500 bbl per day. The pay is the Devonian sand at 3060-70 ft. The well is 4 miles northeast of Nashville in the Beaucoup area. E. J. Cunningham has drilled the Lewis Downen No. 1, 5 miles southeast of Norris City. A 20-minute drillstem test had gas in 20 minutes and 780 ft of oil from the Benoist sand at 2895-2903 ft. The well will be completed with cable tool.

CANADA

• Canadian exploration activity reached an all time high in 1952, and 1953 is slated for even greater operations. The Peace River region will be watched with much interest. It is here that considerable gas reserves have been discovered.

Socony Vacuum, Woodley Petroleum, and Southern Production Company hold interests in a million acre block in the Swift Current area in southwestern Saskatchewan. A successful test has just been completed in the block, Socony-Woodley-Southern North Premier No. 30-4B. Oil was recovered in 90 minutes from the Roseray sand at 3250-3286 ft. The well is 5 miles northeast of the Midway field, and some 10 miles southwest of the Cantaur field.

• In the Canadian Williston Basin it is reported that the Tidewater Associated Oil Company has a discovery. The wildcat is Forget Crown No. 1, and is some 40 miles east and slightly north of Weyburn and about 50 miles north of the North Dakota border. The interval tested was 3886-95 ft and gas reached the surface after 7 min and oil flowed in 70 min.

• Some consider that the Delhi-Britalta-Winchell Coulee No. 1, which is now under test, may be another Turner Valley or Jumping Pound or Pincher Creek type discovery. These gas fields are the largest in the Province to date. The well is some 35 miles northwest from Calgary. It is drilled to 10,892 ft. The Madison lime has been penetrated with an exposure of some 200 ft. Core analyses indicate a porosity of 24 per cent and high permeability.

DENVER-JULESBURG BASIN

• Seven exploratory well sites were staked in the northeast Colorado sector and southwest Nebraska has also come into prominence.

J. Ray McDermott will drill No. 1 Sprague Ranch in Weld County. Hinman No. 1 is being drilled by Chicago Corporation and Republic Natural Gas. The well is north of the Hart field in Morrill County, Nebraska.

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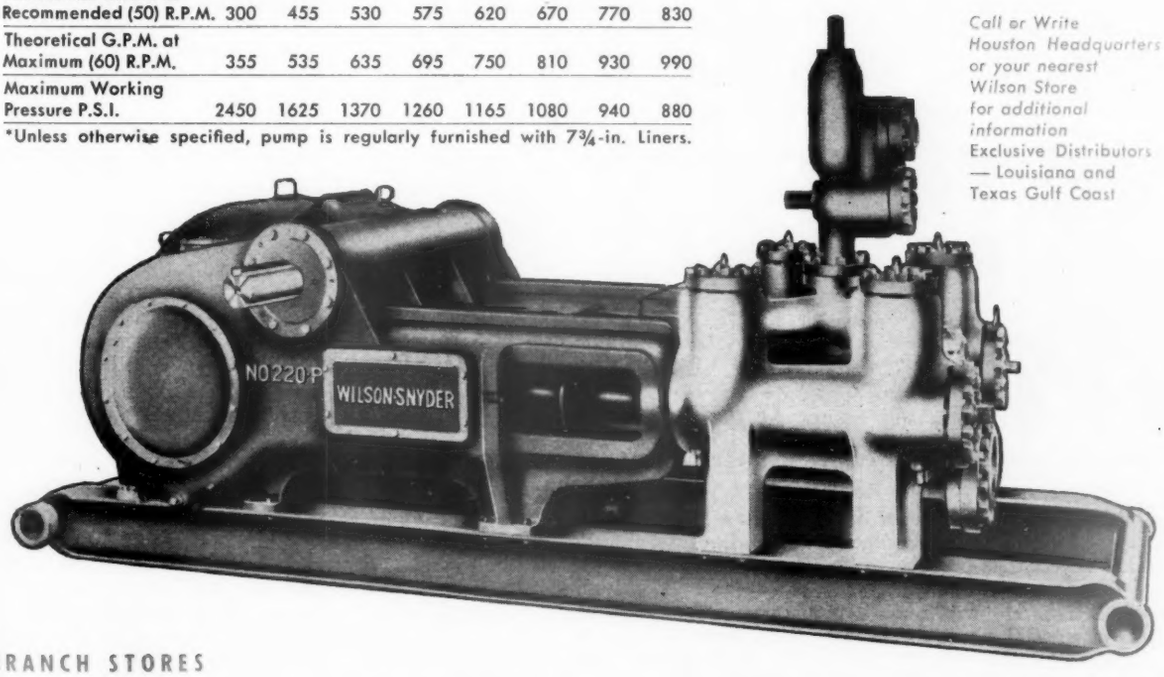

BRANCH STORES

TEXAS — Alice, Corpus Christi, Victoria, Bay City, Columbus, Barbers Hill, Liberty, Beaumont, Kilgore, Monahans. LOUISIANA — Lake Charles, New Iberia, Houma, Harvey, Shreveport.

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Running Tour With Men in the Industry

▸ **E. D. Brockett, Jr.,** formerly chief, exploitation and engineering branch, production department, Gulf Oil Corporation, has been appointed assistant to the general manager, Mene Grande Oil Company, a subsidiary company of Gulf engaged in oil production in South America. He will have headquarters in Caracas, Venezuela.

L. G. May, previously assistant to the chief of the exploitation and engineering branch, has been appointed acting chief of that branch, succeeding Brockett. May's primary function will be to act as an advisor to the vice president of the production department on matters of drilling, production, and engineering.

Brockett joined Gulf as a roustabout in 1934 following his graduation from Texas A & M College.

May joined Gulf in 1938 as a roustabout, following his graduation from the University of Oklahoma with a BS degree in geology and petroleum engineering.

▸ **Robert L. Bradley** has been named supervisor of oil appraisals and **Joseph B. Bush,** supervisor of gas appraisals for Keplinger and Wanemacher, petroleum engineers of Tulsa, Oklahoma.

Bradley has more than 19 years experience in appraising oil and gas properties, and has been with the firm seven years. He began his oil career with Gulf Oil Company. Bush has been with the firm four years, and has had 20 years experience in appraising oil and gas properties. A graduate of Stanford University, he began his oil career with the Shell Oil Company in Texas.

▸ **C. C. Lister** has been named president of United Geophysical Company. Herbert Hoover, Jr., continues as chairman of the board of directors and maintains his offices with the company in Pasadena, California. **R. G. Sohlberg,** recently manager of Canadian operations, has moved to the Pasadena headquarters of the company as vice president of operations.

C. C. Lister

S. O. Patterson, who was formerly assistant manager in Canada, succeeds Sohlberg as Canadian manager.

After graduating from Texas Tech and serving in the geophysical department of Mid-Continent Petroleum Corporation at Tulsa, Lister joined United Geophysical Company in 1937. After serving as manager in Venezuela he moved to the Pasadena office and became manager of United's foreign operations. More recently, he has been vice president in charge of operations.

▸ **Ellis W. Hamilton,** junior engineer for Western Gulf Oil Company at Fruitvale near Bakersfield, has been appointed petroleum engineer in the Oak Canyon field near Castaic. Hamilton first joined Western Gulf Oil Company as a trainee. After a leave of 16 months, he rejoined Western Gulf in 1949, as a junior engineer in the Fruitvale field, a position he held until his transfer to Oak Canyon field.

▸ **W. Dow Hamm,** general manager of exploration, Atlantic Refining Company, has been named president of the Dallas Geological Society. Other officers include: Henry Rogatz, consultant, vice president, G. Frederick Shepherd, chief geologist, General American Oil Company, secretary-treasurer; Paul E. Nash, director of Geophysical Exploration, Magnolia Petroleum Company, executive committeeman, and Wallace Ralston, geological department, Sun Oil Company, past president.

▸ **Robert G. Parker,** who has been associated with Continental Oil Company's oil and gas production activities since 1939, has been promoted to production manager for Conoco's central region, with headquarters in Oklahoma City. Parker joined Continental as a driller and derrick man at Ventura, California, and by 1948 had become district petroleum engineer for the company's West Coast production activities. In 1952 he became assistant production manager of Continental's southwestern region, at Fort Worth. He is a graduate of the California Institute of Technology, Pasadena.

▸ **Gradon H. Laughbaum** has been named chief geologist for Three States Natural Gas Company, Dallas, Texas. A graduate of the University of Oklahoma, Laughbaum resigned his position as division research geologist with Sinclair Oil and Gas Company after 27 years service.

D. H. Byrd is head of the Three-States Company, which was established in 1950.

J. B. Sutherland

George Sowards

E. Paul Ward

I. G. Burrell

N. E. Trumbull

J. H. Shonk

▸ **J. B. Sutherland,** Los Angeles division manager of The Ohio Oil Company since 1941, has left that position to become assistant to the company's manager of production. He will remain in California on special assignments for Emery.

George Sowards, chief petroleum engineer in the general office at Findlay, Ohio, will succeed Sutherland as Los Angeles division manager.

E. P. Ward, assistant to the manager of production at Findlay, has been appointed chief petroleum engineer.

I. G. Burrell, division superintendent at Terre Haute, Indiana, will become assistant to the manager of production at Findlay.

N. E. Trumbull, district petroleum engineer at Bakersfield, California, has been appointed division superintendent at Terre Haute.

J. H. Shonk, special assistant to the Terre Haute division superintendent, has been appointed assistant division superintendent at Terre Haute.

Sutherland joined The Ohio Oil Company in 1917 at Basin, Wyoming, and was transferred to Casper, Wyoming, in 1918. He became secretary to the Casper division manager in 1919, and Los Angeles division manager in 1941.

▸ **Emmett A. Vaughey,** who has been deputy director of the production division of the Petroleum Administration for Defense since mid-December, has been appointed director of the division, succeeding **Robert L. Foree.** Foree, who joined PAD's staff in November 1951, has been director of the production division since January 1952. He has resigned to return to Dallas, Texas, where he is an independent oil operator. Vaughey, who will serve without Government compensation, has been an independent oil operator with headquarters in Jackson, Mississippi. He studied law at the University of New Mexico.

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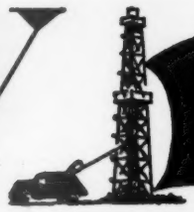

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Nomad Officers for the New York Chapter for 1953 include A. A. Dill, G. I. Lynch, Edmund Burke, Jr., C. J. DeLay, R. V. McIntire, O. B. Latrobe, N. L. Boulden, Jr., L. F. Griffith. At right, retiring president Dill presents the New York Chapter gavel to incoming President Russ V. McIntire, who was elected to office at the group's January meeting.

▸ **Russ V. McIntire,** Baker Oil Tools, Inc., will head activities of the New York Chapter of Nomads as president during 1953. Other new officers elected at a business meeting recently in New York City are: C. J. DeLay, Continental Supply Company, vice president; O. B. Latrobe, Hughes Tool, secretary; G. I. Lynch, Lee C. Moore Corporation, assistant secretary; N. L. Boulden, Jr., International General Electric, treasurer; L. F. Griffith, Petroleum Machinery Corporation, assistant treasurer; Edmund Burke, Jr., General Motors Overseas Operations, sergeant-at-arms; H. B. Book, Reed Roller Bit, regent; A. A. Dill, Axelson Manufacturing, regent.

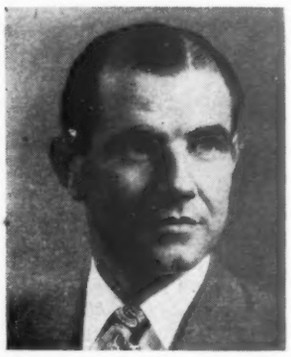
▸ **C. M. Hartwell,** who has just returned from service in the armed forces, has been named district superintendent for the oil production division of Cities Service Oil Company at Hobbs, New Mexico. Hartwell will have charge of the oil production properties formerly handled by **R. W. Ely.** Ely, who is assistant division superintendent, will be assistant to **D. D. Bodie,** division superintendent of all West Texas-New Mexico operations.

▸ **L. J. Forche** has been named exploitation assistant for Sinclair Oil and Gas Company. He has been attached to the central division with headquarters in Tulsa, Oklahoma, for the last 10 years. A Sinclair employee since 1926, Forche will be responsible for all preliminary work in connection with the recommendations leading to the commencement of all Sinclair Oil and Gas Company drilling operations.

▸ **W. D. Yale** has been promoted to assistant division manager of the gas division, The Texas Company's producing department. Yale, who replaces **M. J. Adams,** newly-appointed division manager of Texaco's LPG purchases and sales division, will be succeeded by **R. H. Park** as chief engineer, gasoline and cycling plants of the gas division. Both men will be at Houston.

Yale is a chemical engineering graduate of California Institute of Technology. He has been with the Texas Company since 1938, since 1945 as chief engineer gasoline and cycling plant.

Park, who was born at Port Arthur, is a chemical engineering graduate of Massachusetts Institute of Technology. He joined The Texas Company as chemist-laboratory, Port Arthur Works, in August, 1939. He was named gas engineer in May, 1951.



Neal D. Williams

▸ **Neal D. Williams** has been named manager of the land department of Monterey Oil Company, succeeding **C. R. Pickering.** Pickering, who has been 16 years with Monterey and its predecessor, Jergins Oil Company, and is well known in western petroleum circles, has resigned and will devote his time henceforth partly to his ranch interests and partly to consulting practice in lands and leasing. Williams attended Fordham University, Tulsa University Law School and was awarded his law degree by the Pacific Coast School of Law.

▸ **Robert E. Hart** has been named division landman for the Southern division and **L. A. Braly** as district landman for Oklahoma, for Cities Service Oil Company. Hart was first employed by Cities Service in 1940 and has served as landman for Cities Service in various cities. Braly was employed by Cities Service in 1947 as titleman in the Bartlesville office and was transferred to Fort Worth, Texas, in 1950 as district landman there.

▸ **W. R. (Bill) Beam** had been appointed landman of the oil development department, Northern Pacific Railway Company. Beam has been district landman for The Carter Oil Company at Denver, handling the Denver-Julesburg Basin and farm-outs for the Northwest.

▸ **L. W. Randerson,** petroleum engineer at Midland, Texas, for Magnolia Petroleum Company, has been promoted to senior petroleum engineer. Magnolia announces several other promotions and transfers among its petroleum engineers. **B. A. Barnes** is promoted to section chief in charge of fluid injection and hydrology. **Charles F. Girand** and **Gerald L. Smith,** Dallas, become senior petroleum engineers. **Gilbert M. Andreen,** Dallas, has been promoted to district engineer and transferred to the Alice producing district. **John D. Howard,** formerly at Vanderbilt, has been promoted to district petroleum engineer at Vanderbilt, succeeding **W. A. Daniel,** who has been transferred to Kermit, Texas, as district petroleum engineer.

J. W. W. Whitney, Jr., Shreveport producing district, has been promoted to district petroleum engineer at Wewoka, Oklahoma. **A. J. Menzingo,** formerly of Wewoka goes to Salem, Illinois, as producing petroleum engineer. **Jack H. Ray,** Brownfield district, has been promoted to district petroleum engineer, Rodessa district, headquarters Rodessa, Louisiana. **Ollie J. Ford,** formerly at Kermit, goes to the proration section of the Dallas department. **Robert F. Ritchie,** Kermit producing district goes to the Shreveport, Louisiana, district.

John P. Lowe, Jr., formerly at Falfurrias, goes to the Alice producing district. **John N. Schuelke** has been transferred to the Falfurrias district. **Norman Bellinger,** Cushing producing district, is transferred to the Vanderbilt district. **James D. Harrington,** Kermit district, has been moved to the West Texas division offices, Midland, Texas. **Oscar C. Person,** Alice producing district, is transferred to the West Texas division offices, Midland. **Charles W. Hickok,** Electra, Texas, has been transferred to Brownfield, Texas. **J. A. Petty,** Rusk district, has been moved from Kilgore to the Cushing producing district, headquarters at Drumright, Oklahoma.

SYNTHETICS FOR JET ENGINES

"Tailor-made" lubricants, designed for the specific job, appear to be the only solution

ARCH L. FOSTER*

More recent developments in the technology of jet engines indicate without peradventure of doubt that pure petroleum-based oils are inadequate to meet the continuingly more severe conditions imposed on lubricants and metals alike by the newer designs. This applies to both turbojet and turboprop types, and already the aviation and petroleum industries are "doing something about it."

For a considerable time in early jet engine history petroleum lubricating oils especially when aided and strengthened by the addition of various property-improving materials gave fairly satisfactory service in the first big-time jets. Operating conditions imposed on oils and design materials were not so severe in these early models. As engines have been improved for greater power output and higher plane speeds the operating conditions have increased in severity, until now the demand for super-lubricants is insistent. Earlier engine bearing temperatures seldom went above 300 F, and cooling units brought the "oil-in" temperatures down to 150-180 F. Turbojets used low viscosity oil meeting then standard specifications. Turboprops, because of their reduction gear lubrication, used heavier (higher viscosity) oils or mild E. P. (extreme pressure) oils, and sacrificed low temperature performance to obtain the greater load-carrying capacity of the higher viscosity petroleum-derived oils. Turbojets did not require this extra load-carrying capacity and could use oils permitting starting at the low temperatures of minus 40 F in British specifications, minus 65 F in U. S. aviation requirements.

In newer designs bearing loads and temperatures have risen seriously, and 450 F is not uncommon. Oil returning to the lubrication system at 225 F is typical; cooling becomes a serious problem. Requirements inevitably call for oils that possess, in greater degree than petroleum-based oils alone can show, high heat and oxidation resistance at these temperatures; extremely high viscosity index, to provide low viscosity at the specified subzero temperatures combined with adequate viscosity at the higher operating temperatures; low volatility or high flash to reduce oil consumption to a permissible level, and adequate availability in large quantities.

To obtain these products technologists of the two industries have turned mainly to two types of compounds, all or most of which are or can be derived from petroleum and/or natural gas hydrocarbons by synthetic methods. These two main types of chemicals are organic diesters, and polyolefin glycols. Other materials that can be used in some applications, especially for severe operating conditions outside aviation are high-boiling alphatic monoesters; polyalkylene oxides such as polyisopropylene oxide; polyalkyl silicones and the highly substituted flurohydrocarbons. Each of these types of products have certain definite advantages and disadvantages that make them satisfactory for certain uses.

Although the most severe conditions of operation where synthetics are indicated is at high temperatures, as in jet engines, along with cold starts in Arctic climes, trucks, cars, tanks, and other specially applied engines, mainly military equipment, operated in subzero weathers offer analogous problems. The entire field is under closest study and research, not only for the purpose of meeting immediate problems for existing designs but to provide for solving problems indicated by trends to future developments. Data presented herein are taken from papers before the Society of Automotive engineers in its November, 1952 meeting.

In jet engines diesters and homologous products have shown good advantages. Table 1 shows various components and their sources from which esters are produced as synthetic specialty lubricants. Note that the list includes both mono-and dibasic organic acids, and mono-and polyhydric alcohols which, combined chemically, form the esters required. Of the nine acids mentioned, at least four are obtainable from petroleum and/or natural gas, while all the alcohols can be synthesized from those raw materials. Technologists now believe that, probably, "petroleum-source synthetic products will eventually be the most widely used type," as stated by Crampton and collaborators of Standard Oil Development's research team.

Polyalkylene glycols are synthesized from olefin oxides, have high viscosity indices, low volatility, but must be inhibited properly to reduce oxidation tendencies and high consumption. Oxidation products from these oils are largely more volatile than the original materials, and thus oxidation instability promotes oil consumption. For gasoline engines, that is, those employing volatile (gasoline) fuels in piston-type designs, they have high detergency inherently. They are not subject to pour point stability problems, containing no wax, and will maintain original low pour points in engine use. In low viscosity ranges they are miscible with mineral oils, allowing blending to retain low pour properties, as well as high temperature viscosities of the synthetics. Also these blends may be compounded with more conventional oil additives.

For aviation (jet engine) oils the esters have been studied widely. Before adaptation to engine service they are among those products employed for instrument and gun mechanism lubrication at especially subzero temperatures, and as "power transfer" fluids. So far all of those used are made mainly from the three acids mentioned in Table 1, adipic, sebacic, and azelaic. Pelargonic and caprylic acid derivatives have been studied also to a lesser degree by some researchers. Typical properties of esters

TABLE 1. Sources of esters of interest.

Prime source	Acids Dibasic		Alcohols Monohydric	Prime source
Petroleum, Coal, Oats	Glutaric, Adipic	E S T E R I F E D	Pentanols	Fermentation, Petroleum, Natural Gas
Stockyards Fats, Castor Beans, Turpentine	Azelaic, Sebacic, Pinic		Hexanols, Heptanols, Octanols, Nonanols	Natural Gas, Petroleum
	MONOBASIC		POLYHYDRIC	
Natural Gas	2 Ethylhexanoic, 3,5,5 Trimethyl-hexanoic		Triethylene Glycol, Polyethylene Glycol, Dipropylene Glycol, Tripropylene Glycol, Polypropylene Glycol, Branched-Chain Glycols	Natural Gas, Petroleum
Stockyard Fats, Castor Beans	Pelargonic, Caprylic			

*Editor, Refining and Gas Processing.

from four of these acids are shown in Table 2. All these critical properties are enhanced greatly over those for typical mineral oils. ASTM viscosity indices range from 124 for isodecyl ester of pelargonic acid to 145 for di-isooctyl adipate. Flash points range from 345 to 405 F, with pour points below minus 70 F. Remarkable viscosity properties are shown, with di-propylene glycol dipelargonate and di-sec.-amyl sebacate in about the same range among the heavy products, up to only 2990 and 2500 centistokes, respectively, at minus 65 F. Pelargonic acid, being a straight-chain, nine-carbon, monobasic acid, here combined with a polyhydric alcohol (glycol) shows that the type of dibastic acid is not critical, to obtain good viscosity index properties.

These synthetic products that have shown best and most promising results are not associated molecularly and are composed of "flexible linear chains of atoms," according to W. A. Zisman of the Naval Research Laboratory. A good basis now exists, based on the extensive research carried out in postwar years, for predicting the properties of variants and derivatives of these synthetics, since they are chemically homogeneous, without "impurities" to confuse predictions.

Under thick film or hydrodynamic operating conditions the heat transfer and rheological properties of the lubricant are most important but when boundary lubrication conditions exist, the work of the lubricant is determined by not only the physical properties of the surfaces, but by the type of surface reactions that take place between the surfaces and reactive elements in the oil. To enhance the specific properties of an oil as may be required, it is realized now that it is better to synthesize the "main body" of the oil and to add "reinforcements" to improve further the properties of the oil to resist wear, seizure, and corrosion.

In earlier work the diesters were oxidation-inhibited by either phenothiazine or dialkyl selenides, and extensive engine and flight tests both here and in Britain proved that so fortified, the diesters give better performance at either low or high temperatures, lower oil consumption, proper low temperature starting, and lowered fire hazard. The first anti-wear agent that gave no corrosion effects was tricresyl phosphate, which increases the minus 65 F viscosity considerably.

Some comparisons of the difference between the properties of petroleum oils used in early jet engines, and those synthetics now found much more serviceable in performance are shown in the accompanying Table 3 (Table 4 in Zisman's paper). Grade 1010 was the petroleum oil first adopted just after war's end. Later the diesters, and then the same fortified with addition agents came into use with most gratifying results. Eventually specification MIL-L-7808, in the last column, Table 3, was formulated to govern a standard grade of these lubricants, called on to lubricate both turbojet and turboprop engines with the reduction gear system of the latter. The new specification raises the 210 F viscosity somewhat above G1010, 2.53 to 3:00 centistokes (minimum). The great discrepancy lies in the minus 65 F viscosity, G1010 showing about 40,000 centistokes, as compared to a 10,500 typical of the new requirement, and a 13,000 (maximum). The three esters shown have this low temperature viscosity ranging from 7000 to 8600, well below the maximum set. These values result in a viscosity index of 141 to 154, with a standard of 147 in the new specifications. Flash and fire are improved correspondingly, while evaporation loss for the new standard is 0.1 wt per cent, or 1/80th of that for the early petroleum oil product that showed 8 per cent loss at 210 F.

TABLE 2. Properties of di-esters.

	Viscosity, Cs.*, F°				ASTM VI	H&N VI	Flash	Pour
	210	100	0	−65				
di-propylene glycol di-pelargonate*	2.58	9.1	90	2,990	129	149	405	below-70
di-isooctyl adipate	2.84	10.1	130	13,000	145	152	390	below-70
di-sec.-amyl sebacate	2.30	7.5	80	2,500	133	157	385	below-70
di-(2-ethylbutyl) azelate	2.31	7.3	75	2,300	144	163	385	below-70
isodecyl pelargonate	1.78	5.2	31	609	124	169	345	below-70
di-isoamyl adipate	1.73	4.94	37	660	127	173	345	below-70

* Cs. = centistokes.

TABLE 3. Properties of promising synthetic oils for comparison with grade 1010 oil and Mil-L-7808 oil.

Property	MIL-0-6081 Grade 1010	Bis(isoctyl) Adipate*	Bis(2-ethyl-hexyl) Azelate	Bis(2-ethyl-hexyl) Sebacate	MIL-L-7808	
Viscosity, cs. at 210 F	2.53	2.8	3.1	3.3	3.28 (3.0 min)	
100 F	10.3 (10 min)	10.0	11.4	12.6	12.68 (11.0 min)	
0 F	220	135	156	187	200	—
−20 F	685	330	380	445	490	—
−40 F	2600 (3000 max)	1040	1190	1410	1600	—
−65 F	40,000 Ca	7000	8000	8600†	10,500 (13,000 max)	
Viscosity index	70	141	146	154	147	—
Pour point, °F	<−70 (−70 max)	<−75	<−75	<−67	<−75	−75
Low temperature stability	—	<−75	<−75	<−67	<−65	−65
Flash point, °F	300 (265 min)	370	445	450	450	385
Fire point, °F	—	430	470	490	490	—
Evaporation loss 210 F wt, per cent	8 Ca	1	0.2	0.1	0.1	—

* Isooctyl alcohol is a mixture of isomers, predominately dimethyl hexanols made by "oxo" process.
† Interpolated or extrapolated.

As to supplies of raw materials and intermediates for these esters and poly glycol derivatives the outlook is bright and very satisfactory. Innumerable variations in properties are possible by varying the configurations and molecular structures of the reacting components in both esters and glycols. In addition to the acids mentioned such others as suberic, glutaric, pimelic, and caproic may be employed to add or modify various properties. New esters are made by reacting branched-chain monobasic acids with any number of glycols, (dihydric alcohols). Branched-chain glycols are combined with any of a large number of straight-chain acids as pelargonic, caproic, and caprylic. As indicated in Table 1, many of these acids are derived from animal and vegetable fats, and thus their source material is assured continuously. Pelargonic acid is a by-product of the manufacture of azelaic acid from stockyard fats. Azelaic acid is employed in making synthetic oils and plasticizers, etc., and a use for pelargonic acid would inevitably reduce the cost of azelaic. A huge number of alcohols, glycols, esters, etc., can be and are made from several sources, insuring plentiful supply and freedom from monopoly of supply, as well as from critical situations that would arise in the event of elimination of a single source. Ethylene and propylene, and other aliphatic olefins are obtainable in unlimited amounts from petroleum and natural gas; reactions forming the oxides are simple and low cost. Silicones are derived from sand (silicon dioxide), coal, chlorine, natural gas, and magnesium, plentiful supplies of all being certain. Their expensiveness is not the cost of raw materials but the number of highly involved chemical steps through which the materials must pass before silicones are obtained. The same things are true in general of fluorocarbons, (obtained from hydrocarbons and fluorine or hydrofluoric acid), with the exception of a possible shortage of calcium fluoride; manufacturing costs make these products cost around $10 per pound, or higher, a price not likely to be reduced importantly.

In similar fashion ultra-low pour point oils for automotive use in Arctic climates, that do not thin out too much at operating temperatures are of immense value to commercial and private users, indispensable to military operations. Both the esters and the polymerized oxides and glycols are being employed for this purpose, both "straight" and in compounding with mineral oils. Commercial additives are compounded with mineral and synthetic oil components to make diesel oils, gasoline engine oils, and similar products of outstanding performance. The great improvement over the ultra-light mineral oils recommended earlier is that the very excessive consumption of the latter is reduced to normal proportions, 1/10th to 1/80th of the mineral oil consumption, while adequate load-carrying capacity for higher operating temperatures is obtained. It is believed that the 5W types of oils will not be accepted by the public until both consumption and load-carrying factors are improved by addition of synthetics. * * *

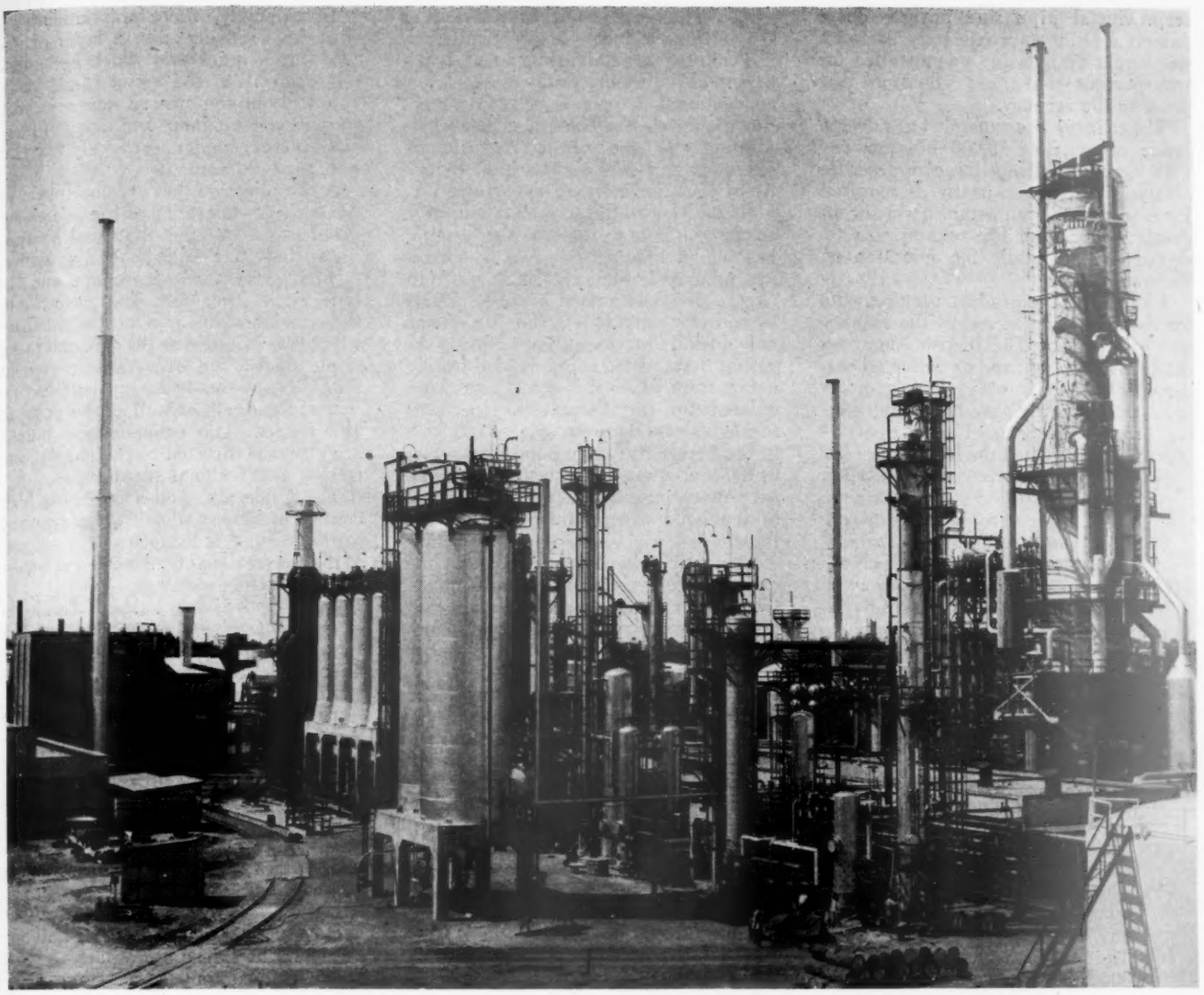


FIG. 1. General view from the southeast of the new processing units. Left to right: Coking heater and drums, catalyst storage hoppers, gas concentration unit and polymerization unit, fluid catalytic cracker.

Moose Jaw, Canada, Refinery Expansion

Peculiarities of crude oil and local product demands has resulted in unique plant design

C. F. TEARS* and C. FREDERICK TEARS, JR.*

PROCESS and mechanical engineering design of the extension to The British American Oil Company, Ltd., Moose Jaw, Saskatchewan, Canada, refinery was a most interesting problem. The geographical location with its effect on the product requirements, the product specifications, the utilities and mechanical details gave rise to unusual problems not frequently met in design assignments of this kind. The development of the problems resulted in a unique refinery installation.

The existing Moose Jaw refinery was originally built in 1934 when it was completed as a simple combination topping and thermal cracking installation. It was extended in 1943 by the addition of a vacuum unit for the production of asphalt. In 1950 the owners decided to extend it again to supply all refined product demands for the surrounding area. At that time the refinery was operating at a charge rate of 6000 bbl per day of crude in a conventional topping, vacuum reduction, and thermal cracking operation.

During most of its early life the refinery operated on crude imported into Canada from long distances at a tremendous disadvantage in transportation costs for crude. The development of the Alberta oil fields and the completion of the Interprovincial Pipe Line for transporting the Alberta crudes to the East immediately resulted in a domestic supply of crude oil for the refinery. The In-

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terprovincial pipe line passes Moose Jaw at a point approximately 22 miles east and a branch line was installed for transporting the crude oil from that point to the refinery.

The refinery was expanded to a design crude capacity of 10,000 bbl per day with a comparatively large increase in catalytic cracking capacity as required for a relatively high octane level for all gasoline produced. The refinery was designed fundamentally for operation on Redwater crude.

A survey of the product requirements for the area to be served by the refinery was prepared by The British American Oil Company, Ltd., and as indicated earlier this statement of product requirements immediately gave rise to interesting process problems. The product requirements indicated the following:

(1) The octane level of all gasoline to be produced was relatively high, 86 research octane for regular gasoline and 89 research octane for the premium grade.

(2) Specialty products in the way of lighting naphtha, cleaning naphtha, and asphalt cutback were required but only to the average production of 86 bbl per day or less than 1 per cent of the rated crude charge capacity.

(3) The finished kerosine demand for that area was only 70 bbl per day while the normal crude topping operation produced some 1100 bbl per day.

(4) There was a demand for 530 bbl per day of tractor fuel.

(5) The demand for diesel fuel was relatively high at 1025 bbl per day.

(6) The requirement for asphalt was 300 bbl per day, and the normal topping and vacuum reduction yield was 1420 bbl per day.

(7) The total market requirement for heavy fuel oil or Bunker "C" was 12 bbl per day.

A laboratory break-up on Redwater crude showed the expected topping yields as follows:

Gasoline, 400 end point	32.1 per cent
Kerosine	11.2 per cent
Combined light distillates . .	18.9 per cent
Vacuum distillate . .	21.1 per cent
Asphalt	14.2 per cent
Loss	2.5 per cent
Total	100.0 per cent

Comparison of these expected topping yields with the product requirements developed the following:

(1) The expected demand for kerosine was only 6.4 per cent of the total potential production.

(2) The market requirement for light distillates of all types was only approximately 82.4 per cent of the total production from the crude topping operation only.

(3) The market requirement for asphalt was only 21.4 per cent of the potential production.

(4) There was no demand for conventional No. 2 fuel oil or domestic fuel.

(5) The demand for heavy fuel oil or Bunker fuel was practically nil.

The foregoing statements set up a fundamental processing problem which to a conventional refiner would appear at first glance most difficult of solution. The solution was accomplished with the cooperation and able assistance of British American's engineering department.

In addition to the problems indicated on the processing there was also a major problem on the utility system. The existing refinery is situated on Moose Jaw Creek, which is named a creek largely by courtesy only. It is a running stream only during the spring thaws. During the spring thaw, water is impounded behind a dam from which it is continuously circulated for the balance of the year through a cooling tower system and back to the pond. The same pond also serves as the source of cooling water for the local power company. There is no make-up to the pond except during the spring thaw.

The entire steam requirement for the existing refinery was purchased from the local power company and no steam generation was done in the refinery although the refinery did have a stand-by boiler installation.

The electric power was also purchased from the local power company.

In order to extend the water storage capacity as required for the expansion of the refinery a second dam was installed downstream from the original dam providing water storage of approximately twice the volume originally provided. Further, in order to insure a source of make-up water into the storage system during the dry season the effluent from the Moose Jaw city sewage system was clarified and purified and directed into the second water storage pond.

Added to these peculiarities, largely attributable to the geographic location of the refinery, was another geographic difficulty in that atmospheric temperatures during the winter were as low as minus 50 F and the frost line was 7 ft below grade.

Sodium Silicate Production

A plant for the production of sodium silicate in both solid and solution form, by a new process, is part of the facilities being built by The Davison Chemical Corporation at Lake Charles, Louisiana, to manufacture petroleum cracking catalysts and other chemicals, it was announced by R. L. Hockley, president of the company. This will mark Davison's entry into production of sodium silicate — often referred to as "water glass" in its solution form — a chemical used extensively by the company in the production of petroleum cracking catalysts, other catalysts and silica gels. It will also mark further Davison diversification into the heavy chemicals field.

Capacity of the facilities at Lake Charles will be about 300 tons per day of sodium silicate, sufficient not only for the needs of Davison's plant but for other users.

Surprisingly, there was underlying the entire refinery area a layer of water-bearing quicksand which necessitated piling all of the major foundations. Franki type compressed concrete piles were used throughout and many of these were driven under extremely adverse weather conditions.

A complication that did not appear in the early consideration of the processing problem was the fact that final analysis of the Redwater crude showed a relatively high percentage of propane and butane, i.e., 2.5 per cent. This gave rise to the consideration of a crude stabilizer which was installed as the first unit in the crude distillation area. This served to separate out the hydrogen sulfide content of the crude as well as the propane and butane. The propane and butane mixture was directed to the gas concentration unit for final rectification.

The crude also had a relatively high content of water and salt which involved installation of a Petreco desalting unit of the conventional type using a spheroid for the settling zone.

Heat requirements for both the desalter and the crude stabilizer were supplied largely by heat exchange on the crude unit but a direct-fired reboiler for the stabilizer was installed.

The existing thermal cracking heater was converted to use as the crude heater for the crude topping unit. Except for this heater and an existing vacuum unit heater of the box type, all heaters in the installation were of the Petrochem combination radiant and convection type with vertical tubes for both the radiant and convection sections.

The crude distillation is accomplished in two stages in an atmospheric unit and a vacuum unit. The atmospheric unit is a conventional single flash, single tower unit with side stream strippers and is designed for separation and fractionation of all products from the crude through light gas oil. A new atmospheric crude flash tower and auxiliaries was installed in connection with the existing thermal cracking heater, which was rearranged for crude distillation service.

The existing vacuum unit was used for the vacuum distillation section of the crude unit practically without change except for the addition of heat exchange and condenser surface. It was arranged for blocked-out operation to produce either penetration asphalt with all heavy gas oil going overhead to catalytic cracking unit charging stock or a 25 per cent crude residuum for charge to a coking unit.

The stipuation in the product requirements that there was little or no demand for heavy fuel oil necessitated the installation of a coking unit. The type selected was a conventional coking unit designed for coking the entire production of 25 per cent crude residuum. Note that the charge contains 56 per cent of 70 penetration asphalt. As noted elsewhere, the heater for this coking unit was a vertical tube Petrochem type, which is one of few installations of this type of heater in coking service. The coking unit is provided with four 10 ft 0 in. by 40 ft 0 in. coke drums for production of coke at a design rate of 84 tons per day. The coke

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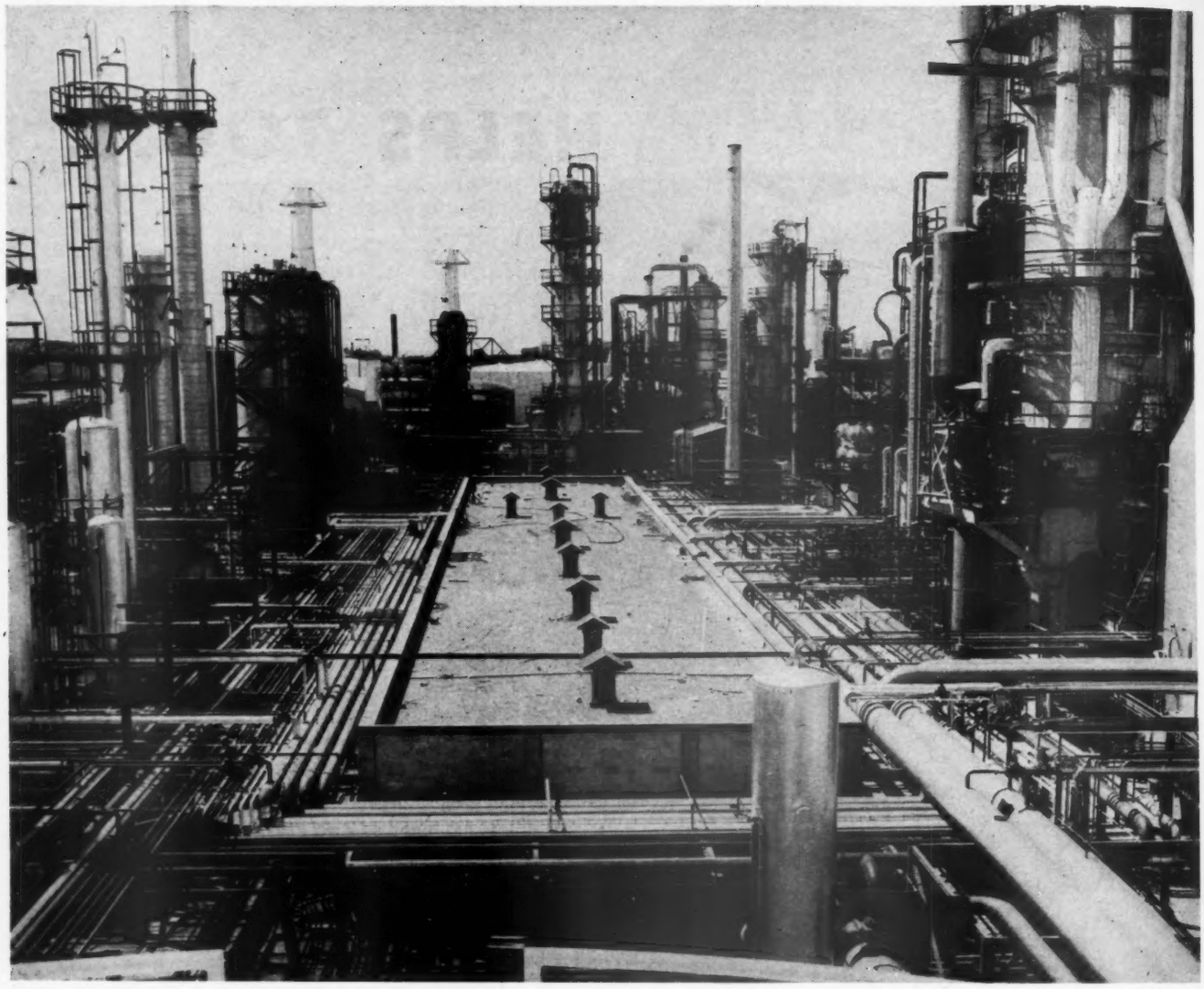


FIG. 2. Centralized pump and control house for the new processing units, viewed from the east. Left to right: Gas concentration unit, coking drums and coking thermal cracking heaters, coking unit fractionating tower (rear, center), three stage crude distillation unit (right rear, vacuum stage, atmospheric stage, crude stabilizer), fluid catalytic cracker (right foreground).

chamber cleaning device is of the Hughes type as provided by Forsythe Engineering Company. The hydraulic type of coke removal installation was given serious consideration but was finally ruled out in view of the larger quantities of water involved in its operation because of the extremely cold winter conditions and the scarcity of water for the cleaning operation.

The complete lack of market for No. 2 fuel oil or domestic fuel oil and the very limited demand for kerosine forced the installation of a thermal cracking unit for charging the light cycle stock from the catalytic cracking unit and the excess production of kerosine from the crude unit. The thermal cracking unit was combined with the coking unit by discharging the thermal cracking heater outlet into the transfer line of the coking unit. Thus, the investment in the thermal cracking unit was reduced practically to the cost of the heater and charging pump only. The fractionating tower and its various accessories and controls were common to the coking unit and the thermal cracking unit. Incidentally, the fractionating tower for this combined unit came from the existing thermal cracking unit in the original refinery.

After an exhaustive study of the units available a Universal Oil Products Company fluid catalytic cracking unit was selected for this installation. The unit is designed for a fresh charge capacity of 4414 bbl per day for a conversion rate of 80 per cent and a cycle ratio of 1:1. The rated coke-burning capacity is 7200 lb per hour.

As is obvious from the over-all description of the catalytic cracking unit, the basis for design anticipates cracking nearly to extinction with minimum yields of light and heavy cycle stock. It was, of course, obligatory that the yields of these two grades of cycle stock be reduced to the practical minimum because of market limitations mentioned earlier; namely, the definite lack of market for No. 2 fuel oil and for Bunker "C" fuel oil, the only normal outlets for these two products.

The fresh charge to the catalytic cracking unit is light gas oil from the crude unit, heavy gas oil from the vacuum unit, and coker gas oil from the coking unit. When the vacuum unit is running for asphalt production the heavy gas oil from it represents that portion of the crude oil from 49 per cent to 86 per cent. When the vacuum unit is running to coker charging stock the heavy gas oil represents only 26 per cent of the crude, from 49 per cent to 75 per cent.

The charge to the coking unit is always reduced crude representing a 25 per cent residue for that time that the vacuum unit is not running to asphalt. As is quite obvious, the coker gas oil mixed with the fresh charge to the catalytic cracking unit is not the most desirable charging stock because of its having been partially cracked in the coking unit. Also it contains the heavier ends of the thermal cracking cycle stock. It is probably equivalent to a first-round cycle stock.

The design basis for the catalytic cracking unit anticipated a production of light cycle stock of 618 bbl per stream day or 6.18 per cent of the original crude charge. The combined heavy cycle stock and clarified residue represents a total

of 265 bbl per stream day or 2.65 per cent of the crude. It is interesting to note that this latter volume is the entire production of heavy fuel oil from the total crude charge.

The over-all yields from the catalytic cracking unit used as the design basis were:

Product	Per cent volume	Per cent weight
Gas	.....	10.38
Total butanes	19.50	12.90
Debutanized gasoline	51.30	43.55
Light cycle oil	14.00	14.35
Heavy cycle oil	1.50	1.38
Clarified residue	4.50	5.15
Coke	.....	12.29
Total liquid yield	90.80	.....
Total		100.00

The non-condensable gas was directed to a gas concentration section designed for optimum recovery of propanes and butanes with the total C_3 and C_4 recovered mixture charged to a conventional chamber type UOP catalytic polymerization unit for the production of stable poly gasoline.

The gas concentration unit handled all gas from the catalytic cracking unit, the coking and thermal cracking unit and the crude stabilizer overhead. The gas concentration unit was designed for a minimum recovery of 70 per cent of the propanes content and 95 per cent of the butanes content. The total design recovery of poly gasoline from this recovered mixture was 436 bbl per day of which less than 10 per cent originated from the coking and thermal cracking unit. Thus, the catalytic cracking unit produced approximately 400 bbl per day of poly gasoline, which represents 9.1 per cent of the fresh charge to the unit. When this is added to the yield of debutanized gasoline from the catalytic cracking unit itself the total gasoline yield from the catalytic cracking operation is 60.4 per cent (Vol.) of the original fresh charge and 26.7 per cent of the original crude charge. Obviously this gasoline product is at a high-octane level and in the same octane bracket may be added 604 bbl of butane produced from the catalytic polymerization and crude stabilization units which can enter the gasoline blends at the Reid vapor pressures specified. This brings the total yield of high octane product to 3310 bbl per day or 33.1 per cent of the crude and 51.0 per cent of the total gasoline produced. The net result in the gasoline blends is that the total production of first-grade gasoline at 89 research octane number and second-grade gasoline at 86 research octane number is produced with an average of 0.88 cc of tetraethyl lead per gallon.

Combined total gasoline yield is 64.85 per cent of the original crude including gasoline from crude topping, coking, thermal cracking, catalytic cracking, and catalytic polymerization and including the butane used in final blends. There was no excess butane produced.

The catalytic polymerization unit includes means for producing and storing commercial grade propane for marketing as domestic fuel. Means are also provided for producing and storing the total production of mixed butanes for eventual disposal in the finished gasoline blends. As noted earlier the combined operation on a year around basis produced no excess butanes beyond the amounts used in the gasoline blends to bring the Reid vapor pressure of the blends to the specified limits.

FIG. 3. Closeup of the coking heater and coking drums, viewed from the southeast. Mechanical decoking with a rising rotary drill is used, with direct loading of the coke into railroad cars by means of the conveyor system in the foreground.

Total production of final gasoline blends of various grades from the combined operation on 10,000 bbl per day of Redwater crude was 6485 bbl per day (64.85 per cent of crude) distributed as follows:

	Barrels per day	Per cent total
First grade—89.0 research octane	2590	39.9
Second grade—86.0 research octane	2510	38.7
Third grade—60.0 research octane (clear)	1355	20.9
Lighting naphtha—no octane requirement	30	.5
	6485	100.0

Not included in the tabulation above are crude gasoline and crude naphthas in the gasoline distillation range to the total amount of 270 bbl per day used in a tractor fuel blend and for asphalt cutback. Addition of this amount brings the total gasoline yield to 6755 bbl per day or 67.55 per cent of the initial crude charge.

The total yield of so-called "White Products," i.e. from liquid propane through the diesel fuel product, was 8416 bbl per day or 84.16 per cent of the original crude charge.

The gasoline product was finished by conventional copper chloride treating in revamped existing treating units.

The complete installation is of the "combination" unit type, with continuous flow of hot stocks and intermediate stocks from one operation to the next in line and with complete integration of controls and auxiliary facilities. All major new units, catalytic cracking, coking, thermal cracking, gas concention, and catalytic polymerization are grouped around a central pump and control house as shown in Fig. 2. * * *

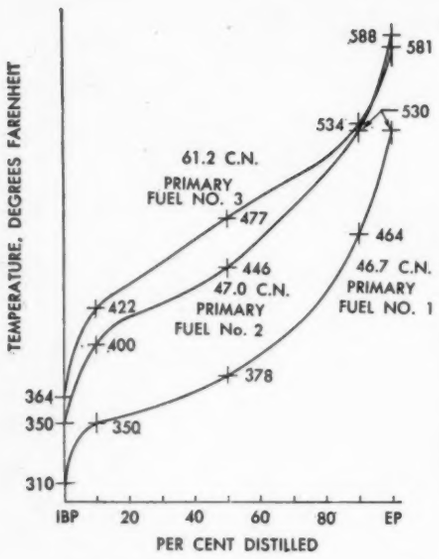


FIG. 1. Volatility and cetane number characteristics of primary fuels.

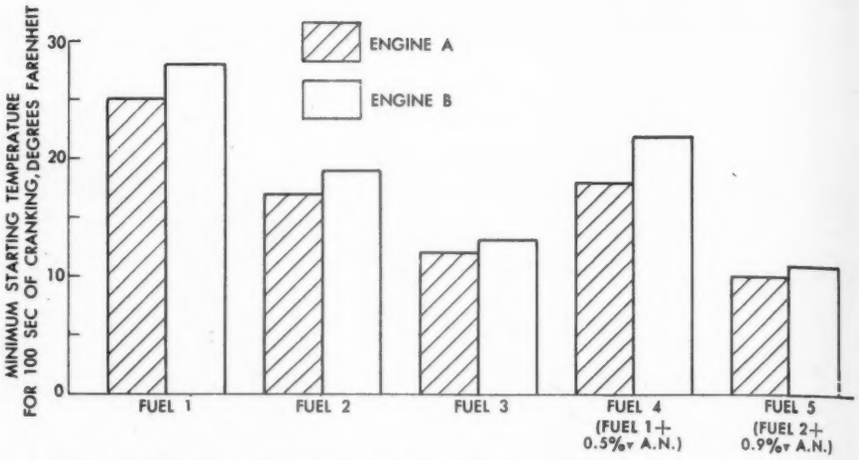


FIG. 2. Influence of primary fuel on minimum starting temperature without a starting aid.

Cold Room Study of Starting Fluids†

Point of injection, quantity of starting fuel injected, and manner of injection all affect performance of diesel engines at sub-zero temperatures

HOBERT D. YOUNG*

THE obtaining of valid comparative data on the performance of fuels and starting aids in diesel engines at low temperatures represent a complex problem. This is due to the many variables which can influence the test results. Broadly speaking, these variables are represented by: (1) the primary fuel; (2) the secondary fuel or starting aid; (3) engine type and design; (4) mechanical fitness of the equipment, and (5) test technique.

Aside from the purely technical aspects of a cold temperature study of fuels and equipment there are also subsidiary problems that must be taken into careful consideration for the successful conduct of such a project.

In the first place the number of personnel needed to carry out the actual work is usually greater than required for most other full scale engine studies. For purposes of obtaining data and also as a matter of safety a three man team is the minimum needed for such work. This does not take into account any additional manpower which may be required for data analysis and work up.

Cold temperature work cannot be conducted with any degree of success by remote control. Test personnel must work on the "firing line" so to speak, i.e., within the cold chamber, for most effective results. This is necessary in order that the observers can gage the "feel" of equipment performance during starting trials. Cold room observers represent key men in such a study and therefore must be selected with some care. Under prevailing test conditions cold room personnel are usually subjected to extremes of temperature and, oftentimes considerable physical shock due to exposure and changes in the working environment. Every precaution must therefore be taken to assure their safety. Not only must cold room personnel be chosen for physical fitness, they must have an expert knowledge of engine equipment together with a high level of technical and research ability as well.

Test work of this type cannot, by any stretch of the imagination, be classified as a morale builder. It is hard and difficult work. Test data are obtained almost painfully and slowly. Continual rechecking of data is necessary. Failure to

The Author

Hobert D. Young, senior technologist, Sinclair Research Laboratories, Inc., joined the Sinclair organization at Chicago in 1928 and for the past 23 years has been on the staff of the Sinclair Refining Company's engine research laboratories, both at the East Chicago refinery and later the research laboratories at Harvey, Illinois. Since 1935, he has been responsible for all engine testing and test development of distillate fuels for diesel and jet engines. He transferred from Sinclair Refining Company to Sinclair Research Laboratories, Inc., when the latter corporation was formed in March, 1951. Young is leader of the Coordinating Research Council—Diesel Fuel Division Ignition Quality Test Group and of the ASTM-DCC Group on Cetane Number Reproducibility and is co-chairman of the Western Petroleum Refiners' Association Diesel Fuel Committee.

†Paper presented at the symposium on "Problems Related to Starting Diesel Engines at Low Temperatures" The Pentagon, May 21, 1952.

*Sinclair Research Loboratories, Inc., Harvey, Illinois.

FIG. 3. Setup of test engines in cold room, for testing starting fluids.

obtain reproducible data is a constant source of discouragement. Under test circumstances such as these, personnel must possess a high level of inherent optimism coupled with native inquisitiveness and an aptitude for meticulous detail.

It is the intent of the principal discussion to highlight a few of the technical problems referred to above that are involved in starting diesel engines at low temperatures. Although the data presented are the result of considerable laboratory work they should not be construed as being fully conclusive. These data are presented for the purpose of demonstrating basic trends that may be sufficiently provocative in character to warrant further study. Those factors to be discussed are:

1. Influence of primary diesel fuel on cold starting.
2. Effect of some engine factors on starting.
3. Point of starter fluid application for maximum effectiveness.
4. Methods of starter fluid application.
5. Effectiveness of starting fluids.

The details of the test technique employed along with a description of engine equipment used are given throughout the discussion.

Influence of Primary Fuel on Minimum Starting Temperature

Five test fuels were prepared for the purpose of exploring the effect of primary fuel on cold starting. These varied in composition, cetane number, and volatility. Two of the fuels contained a cetane number improver. The inspection data on these fuels are tabulated in Table 1.

Fuel No. 1 is primarily a straight run product which conforms to the MIL-F-896 specification for class 3 fuel. Fuel No. 2 is a 50/50 volume per cent blend of high and low secondary diesel reference fuels. One of the components of this blend (U-5 reference fuel) is a highly branched chain paraffinic product having a cetane number of 22.5. The other component (T-12 reference fuel) is a straight run fuel predominantly composed of straight chain paraffins and having a cetane number of 71.5. Fuels No. 1 and No. 2 were purposely chosen to have approximately the same ASTM cetane number, i.e., 47.0. This cetane number level corresponds closely to the average for commercial diesel fuels. It is pointed out that the composition of fuel No. 1 differs from that of fuel No. 2 and that its volatility is somewhat higher, also.

Fuel No. 3 is a 79/21 volume per cent blend of T-12 and U-5 secondary diesel reference fuels. This product is similar in composition and volatility characteristics to fuel No. 2, however. It possesses a substantially higher natural cetane number of 61.0. Fuel No. 4 is the same as fuel No. 1 except that 0.5 volume per cent of amyl nitrate has been added to boost the cetane number up to 61.0 also.

Fuel No. 5 is identical with fuel No. 2 except that 0.9 volume per cent of amyl nitrate was added to raise the cetane number to the same level as that for fuels No. 3 and 4.

The testing of these five fuels under closely identical test conditions permitted the following comparisons to be made:

1. Effect of variations in primary fuel composition (and to some extent volatility) on cold starting. Cetane number held constant.
2. Effect of variations in cetane number level on cold starting. Composition and volatility held reasonably constant.
3. Starting effectiveness of doped and undoped fuels of same cetane number and essentially the same composition and volatility.
4. Starting effectiveness of doped fuels of same cetane number but having differences in volatility, composition and additive level.

The volatility and cetane number characteristics of the base fuels used (Nos. 1, 2, and 3) are shown in Fig. 1.

Fig. 2 gives the minimum starting temperatures obtained on the various fuels when evaluated in a 38.3 cu in., single cylinder, 4 cycle engine and in a 210 cu in., 3 cylinder, 2 cycle engine. Figs. 3 and 4 shows the test engine set up in the cold room. Although data on only two makes of engines are given in this report, actually five different engines are being employed in the current study. These range in size from 38.3 cu in. to 460 cu in.

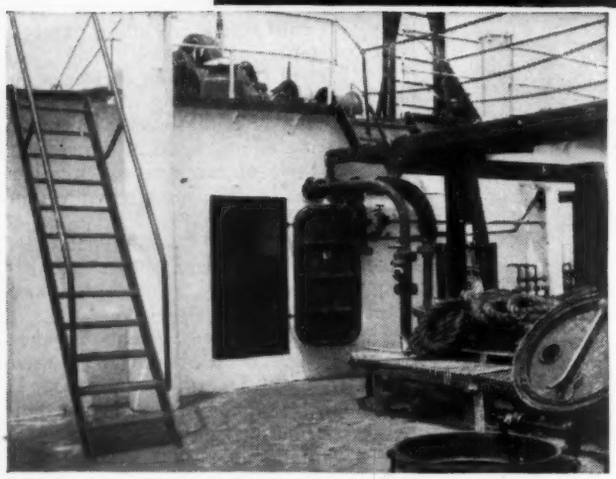
Considering the starting data obtained on these five primary fuels in terms of

TABLE 1. Data on primary fuels.

	Fuel 1	Fuel 2	Fuel 3	Fuel 4	Fuel 5
Gravity API	45.8	47.4	45.3	45.7	47.0
Flash PM	120	148	158	118	136
Saybolt Vis. °100 F	29.4	32.8	33.7	29.5	32.9
KV °100 F (Centistrokes)	1.299	2.216	2.324	1.291	2.165
Cloud	—56	—10	0	—50	—12
Pour	—75	—20	—5	B—80	—20
Color NPA	1—	1—	1—	1—	1—
BS&W	Trace	Trace	Trace	Trace	Trace
Doctor	Pos.	Pos.	Pos.	Pos.	Pos.
% Sulfur	0.070	0.054	0.12	0.079	0.067
Carbon Residue (10% Resid.)	0.119	0.077	0.058	0.106	0.594
Corr. °212 F (CS)	0	0	0	1	0
GM Gum mg/100cc	3.6	9.6	7.4	4.2	9.6
Aniline Point F	144.1	178.3	173.3	143.1	176.3
% Olefins	0.6	5.6	3.3	1.3	5.4
% Aromatics	12.9	5.4	7.7	12.2	5.6
% Nitrogen	0.002	0.003	0.003	0.06	0.12
Bromine No.	1.1	4.7	2.7	1.3	4.6
200 cc Distillation					
IBP	310	350	364	312	307
10	350	400	422	344	386
50	378	446	477	380	444
90	464	530	534	467	525
EP	530	588	581	528	579
Cetane	46.7	47.0	61.2	61.0	61.0
	Str. Run M.1 F-896(C1.3)	50% T-12 50% U-5	79% T-12 21% U-5	Fuel 1 +0.5%v AN.	Fuel 2 +0.9%v AN.

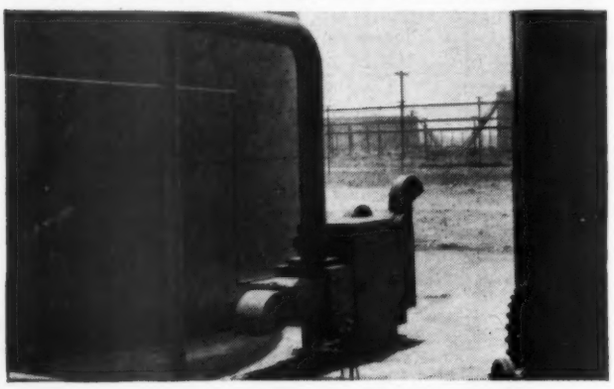
DRY air is carried by a manifold to all parts of this tank farm at the Cicero, Illinois, blending and packaging plant.

Cities Service safeguards its fine lubricating oils with a blanket of DRY air...



From this compartment aboard the Cities Service tanker, SS Winter Hill, a Lectrodryer feeds DRY air to tanks in which lubricating oil is transported.

Lectrodryers like this one at the Petty's Island Refinery are installed around tank farm to safeguard lubricating oil in storage.



At the refinery and aboard ship, at the tank farm and blending plant, Cities Service Oil Company preserves the high quality of its lubricating oils by forcing storage tanks to breathe DRY air. With this blanket of DRY air over the oil at all times, there's no moisture to cause the oil to deteriorate or form rust to contaminate it.

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the four basic comparisons outlined above the following trends are indicated:

1. Under the test conditions employed, fuel No. 2 started both engines at a temperature roughly 8 F lower than did fuel No. 1. As fuel No. 2 is a somewhat heavier product and thus ordinarily would not be expected to start as readily as the lighter fuel, the beneficient influence of fuel composition appears to be indicated. In this connection it is pointed out that routine laboratory inspection data obtained on diesel fuel do not clearly define a fuel as to its composition.

Inasmuch as both fuels possessed the same ASTM cetane number the data indicate, as other investigators have claimed, that this fuel property may not be a fully reliable criterion of the starting characteristic of a fuel where a difference in composition exists.

2. The test data indicate that for fuels of essentially the same composition (and volatility) the one with the highest cetane number may be expected to start an engine at a somewhat lower temperature than the low cetane number fuel. The engine data obtained on fuels No. 2 and 3 tend to demonstrate this. In this particular comparison a 6 F lower starting temperature was achieved by raising cetane number from 47.0 to 61.0.

3. The engine data obtained on the three high cetane number fuels indicate that a fuel whose cetane number has been raised by means of a cetane number improver may or may not be as effective, in regard to cold starting, as a fuel of the same natural cetane number. As will be observed in Fig. 2 fuel No. 4 (doped) is not as effective as fuel No. 3 (natural). On the other hand fuel No. 5 (doped) is as good or possibly superior to fuel No. 3. The reason for this difference may be one of fuel composition. It will also be noted that a higher percentage of additive is required for the more effective No. 5 fuel than for the No. 4 fuel. This may be significant, although additive concentration in different stocks is also a function of fuel composition.

The variation in the effectiveness of the additive fuels may explain the lack of agreement of data obtained by various investigators on the cold temperature merit of fuels containing a cetane number improver versus fuels whose cetane number is an inherent property as determined by crude selection and processing.

4. Although the data demonstrate that additive fuels may or may not perform as satisfactorily as fuels having the same natural cetane number, it is indicated that fuel performance can be improved by adding an improver, such as employed, to the fuel. Both, fuel No. 4 and No. 5, give about 8 F improvement in engine starting over base fuels No. 1 and 2.

5. Depending upon engine type and design as well as cranking equipment employed some difference in minimum starting temperature results when using any particular fuel.

6. Summarizing the overall performance of these five primary diesel fuels, the test data indicate that a gain in minimum starting temperature of perhaps 15 F or more may be obtained through fuel selection. It is realized, however, that fuel selection may be limited somewhat by other fuel requirements that must be met for arctic service, adequate cloud and pour points for example.

FIG. 4. Another assembly of test engines in the cold room.

The data reported above do not represent the results of single tests. All data represent averages of three or more starting trials after the equipment had soaked at the test temperature for a 22-hr period. Non-reproducible data were discarded and starting trials repeated until close agreement was reached on three or more trials and the averages were then made a part of the valid data. Prior exploratory work indicated that starting repeatability could be very good providing all test conditions were maintained.

Influence of Some Engine Factors on Cold Starting

In evaluating fuels and starting aids at sub-zero temperatures, the mechanical condition of the engine equipment was found to be of vital importance in obtaining valid starting data. Engines that would ordinarily check out satisfactorily at room temperature often developed various operating ailments at sub-zero temperatures.

Some of these difficulties were:

1. Valve sticking
2. Injector sticking
3. Injector malfunctioning (poor atomization and dribbling)
4. Increased variation in compression pressures
5. Variations in cranking battery output upon prolonged soaking at low temperature.

In order to minimize engine operating difficulties at low temperatures the following preparation and check-outs were found helpful before moving engine test equipment into the cold room.

1. All test engines if not newly purchased were completely rebuilt in conformance with manufacturer's recommendations.

2. The rebuilt engines were given a 100-hr break-in test on the dynamometer.

3. Compression pressures and injectors of rebuilt engines were checked before and after break-in.

4. All new engines were given an intermittent 6-hr run out at fast idle before being installed in the cold room. During this 6-hr runout period compression pressures and injectors were likewise checked.

Prior to moving the test equipment into the cold room the break-in and engine check-out lubricant was drained from the crankcase and replaced with MIL-O-10295 oil for sub-zero engine operation. This type lubricating oil was employed for all cold room test work.

Even though extensive precautions were taken to assure satisfactory engine performance at sub-zero temperatures through careful engine check-outs, various engine operating difficulties tended to crop up in the course of the initial

TABLE 2. Opening and closing pressures of injectors at high and low temperatures before reworking.

	75 F				−31 F			
	O. P.	C. P.	H. P.	Spray Pattern	O. P.	C. P.	H. P.	Spray Pattern
Rebuilt Injectors								
1	650	600	OK	OK	300	NG	NG	NG*
2	675	625	OK	OK	500	NG	NG	NG
3	650	600	OK	OK	150	NG	NG	NG
New Injectors								
4	600	525	OK	OK	400	NG	NG	NG
5	700	650	OK	OK	600	NG	NG	NG
6	700	660	OK	OK	300	NG	NG	NG
7	650	600	OK	OK	400	NG	NG	NG

* Denotes dribbling and course spray.

work which prevented the obtaining of valid data.

One of these difficulties was intake (4 cycle engines only) and exhaust valve sticking. Another was injector sticking and injector malfunctioning in the case of the 2 cycle engine used. Such difficulties usually resulted in erratic starts as well as engine misfiring at a higher temperature than would normally be encountered if the equipment was operating properly.

The cause of the valve difficulties was traced to the warm-up procedure initially used. At the onset of the work every effort was made to hold engine operating time at a minimum after starting, in order to cut down engine soak periods and thus speed up the test work. In following such a procedure the equipment was operated, once it was started, only long enough to attain steady firing at fast idle. This required about 15 min or less. After this operating level was reached the equipment was shut down and again cooled to the desired test temperature. As the equipment never reached a very high operating temperature by such practice the valve stems and valve guides could not be adequately lubricated. Consequently during a series of tests lubrication of these parts became less and less effective until partial sticking resulted. The warmup period was subsequently extended to two hours after each start and this particular trouble disappeared.

One of the most persistant difficulties encountered in starting the 2 cycle multi-cylinder engine at temperatures of 0 F and below was firing on only one cylinder. This radically affected the minimum temperature at which a positive start could be made with the engine since the power developed by a single cylinder could not overcome the initial drag of the other non-firing power cylinders. At a temperature level (above 0 F) where the engine could be started and made to run on one cylinder it was observed that perhaps 15 or 20 min of warmup time elapsed before the other power assemblies functioned satisfactorily.

As the injectors had been carefully checked out at room temperature it was at first thought that the difficulties encountered were possibly due to too great a variation in compression across the cylinders. Accordingly, these were checked at −31 F and compared with those obtained on the engine at room temperature. This comparison is given below:

	Temperature		
	75 F	−31 F	
Cylinder	Compression pressures, psi		Diff.
No. 1	430	305	125
No. 2	425	300	125
No. 3	418	275	143
Spread between cyls.	12	30	
Cranking speed, RPM	400	120	

As might be expected, the compression pressures at 120 rpm cranking speed were substantially lower than those obtained at room temperature at 400 rpm. This very considerable drop off in compression pressure with lowering of cranking speed clearly demonstrates why it is so difficult to start engines at low temperatures without application of heat or use of special fuels which will autogenously ignite at the relatively low compression temperatures which prevail under such conditions.

It will likewise be noted that the spread in compression pressure between the cylinders increased with a lowering of both cranking speed and temperature. While it is improbable that the 30-lb spread obtained at −31 F would cause serious operating difficulties under running conditions at higher temperatures it is quite likely that a variation of this magnitude would have some bearing on engine misfiring under starting conditions where compression temperatures become more critical in respect to fuel ignition.

This was borne out to a limited extent by the fact that No. 1 cylinder, which had the highest compression pressure, also was the first to fire upon starting. Variation in compression pressure did not appear to be the entire cause of the difficulty, however. Injector performance was also found to be a contributing factor. This was discovered after switching the injectors from one cylinder to another. The pattern of single cylinder firing tended to follow that cylinder in which the No. 1 injector was installed. Upon checking out the three injectors at −31 F using a Buda tester, it was found that the No. 1 injector was the only one of the three injectors which was working properly. Curiously enough all three injectors were satisfactory when again checked out at room temperature.

The influence of the primary fuel was eliminated from consideration as a possible cause of the trouble. This was an arctic grade product of −75 F pour point (See Fuel No. 1 in Table 1). This fuel was used as a reference in all the cold-starting work described herein.

The next step in resolving the problem of injector performance was to set up a check out program at room temperature and −31 F covering a random group of injectors selected from stock. These injectors were checked for opening, closing and holding pressures. Table 2 shows the result of these initial check out tests. The data obtained at −31 F are worthy of note. In all instances the performance was unsatisfactory in respect to opening and closing pressures, spray characteristics, and dribbling.

The logical move in attempting to improve injector performance at low temperatures was to raise the opening pressures. Several methods were tried. These are as follows:

1. By stretching the spray tip valve spring.

2. By installing a thin shim under the shoulder of the spray tip valve (refer to Fig. 5).

The resulting check out data on injectors reworked in the above manner are shown in Table 3.

As will be seen, increasing the opening pressure by either of these two methods improved the check out performance of the injectors at −12 F and also at −32 F. It was further found that by using these reworked injectors in the test engine misfiring was minimized and starting performance noticeably improved. Injector No. 8, however, after a short period of use gave trouble. Upon examination it was found that the stretched spring had returned to its original set. This appeared to be a good indication that a malfunctioning injector could be readily detected in service and that by raising the opening pressure by a suitable method starting performance could be improved. The performance of these modified injectors under normal operating conditions remains to be explored.

It is not the intention to restrict these

TABLE 3. Opening and closing pressures of injectors at high and low temperatures after reworking.

	75 F				−12 F			
	OP	CP	HP	Spray pattern	OP	CP	HP	Spray pattern
Reworked Injectors								
1	900	875	OK	OK	850	800	NG	OK
2	900	875	OK	OK	850	800	OK	OK
3	900	875	OK	OK	900	850	OK	OK
					−32 F			
Rebuilt Injectors								
8*	1000	950	OK	OK	500	650	OK	OK
9	1000	950	OK	OK	900	800	OK	OK
10	1000	950	OK	OK	600	500	OK	OK

* Spray tip valve spring stretched. Pressures built up on other injectors by use of 0.010 in. shim stock.

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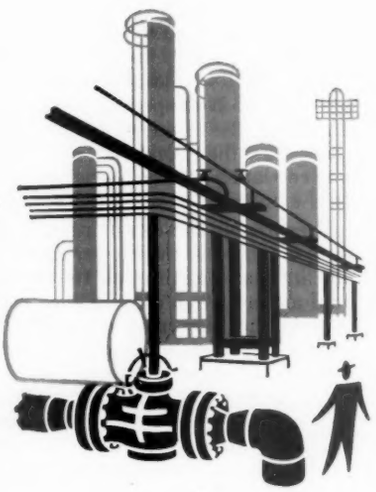

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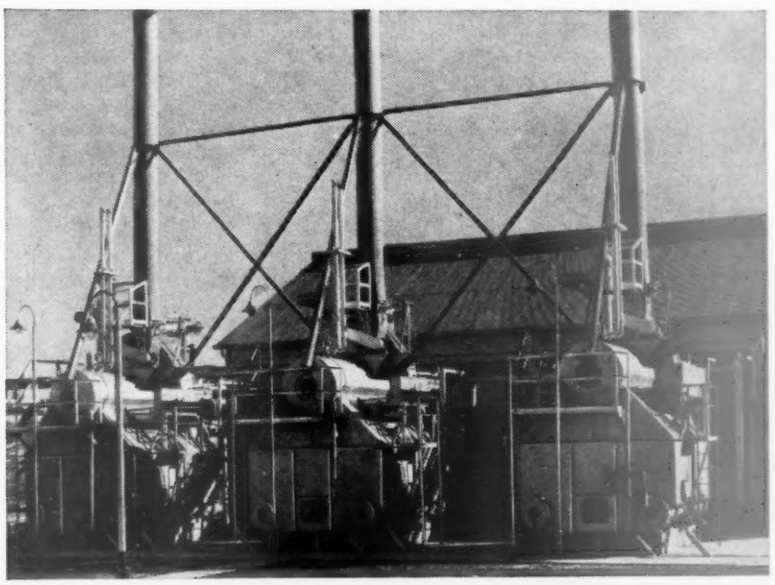

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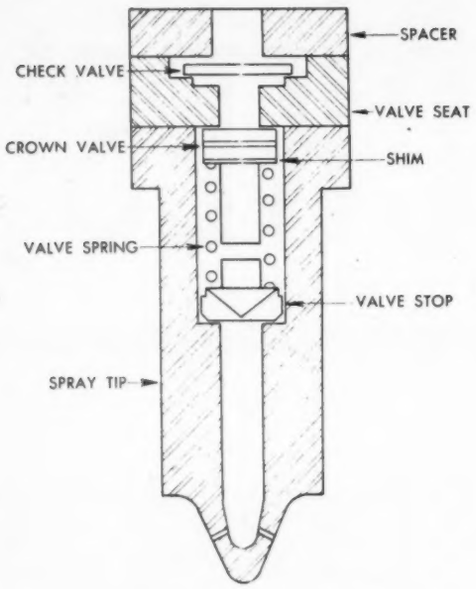


FIG. 5. Details of spray tip assembly unit injector.

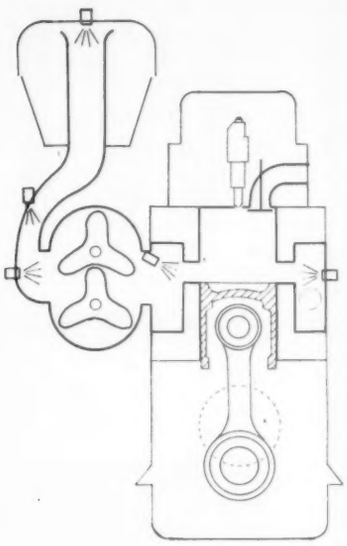


FIG. 6. Points at which starter fluid application was made in a two-cycle diesel engine.

injector studies to only the unit type injector. The performance characteristics of differential pressure type injectors are scheduled to be studied also.

All engines being used in the test program were cranked by an electric cranking motor and 12 volt storage battery. The only exception to this was the work carried out on the Caterpillar gasoline starting engine at the same time.

The batteries employed were of the relatively light duty type such as supplied by the manufacturer for commercial and industrial service at moderate temperatures. Such batteries are not as well suited for continued sub-zero service as Arctic type batteries developed for the purpose. In order to eliminate the influence of the battery factor on the test results insofar as possible all starts were made with a freshly charged, warm battery which was brought into the cold room at the time of starting. While cranking speeds dropped off with temperature, as would be expected, it was possible to maintain the cranking speed of any particular engine within ± 10 rpm for any given temperature level by this practice.

During the early stages of the test program 6-hr soaking periods were employed. This was found to be adequate as it resulted in favorable but fictitious starting data that would not check with data obtained after longer soaking periods. It was found by "cut and try methods" that a 22-hr soak period was satisfactory and would give the same test results as equipment soaked 72 hr or longer. This soak period has been standardized for all subsequent test work. As a soak period of this duration permits only one engine start per day, test data are accumulated very slowly.

In the course of the test work periodic checks on the dilution level of the lubricating oil are made. Whenever the dilution level reaches 3 per cent the lubricating oil is drained from the engines and replaced with new oil. A drain period is usually necessary after approximately 10 to 11 starts at sub-zero temperatures.

Points of Starter Fluid Application

Studies to date covering the most effective point in the air induction system for the application of starting fluids have been confined mainly to the 2-cycle, 3-cylinder test engine. Similar exploratory work, however, is planned for 4-cycle engines as well.

Fig. 6 shows the various locations in the air induction system of the 2-cycle engine which have been explored as possible points of effective starter fluid application. These are as follows:

1. In the air box opposite the blower. Two air box locations were studied in this section of the air induction system. In one location the fluid was directed transversely across the air box into the air ports of No. 2 cylinder. In the other location the fluid was directed lengthwise down the air box towards No. 3 cylinder.

2. On the discharge side of the blower with the nozzle directed towards the interior of the air box.

3. Two locations on the suction side of the blower. In one of these locations the fluid was directed downward towards the entrance to the blower in the same direction as the air flow. In the other location the fluid was sprayed transversely across the entrance to the blower directly into the blower lobes.

4. In the entrance to the air intake pipe on the outlet side of the air cleaner.

These studies indicated that the best point of starting fluid application for this particular engine was through the entrance to the air intake pipe at the air cleaner. This location is also the point of highest velocity through the air induction system. This may account for its being the point of maximum starting fluid effectiveness using cold fluid soaked to the same temperature as the engine. At this point the vaporized starting fluid and air has the best chance of forming a homogeneous mixture that is so important in cold starting. It is pointed out that in other engines the point of highest air velocity may not necessarily occur at the entrance to the air intake pipe. For example, this point in the single-cylinder four-cycle engine employed is in the air intake pipe adjacent to the cylinder. This point of application is also a most effective one from a cold starting standpoint.

Introduction of the starting fluid directly through the ports into No. 2 cylinder likewise appeared to be quite effective. This point of application, however, was exceedingly critical. Severe detonation occurred readily if the rate and quantity of fluid introduced was not controlled carefully. No noticeable improvement in starting effectiveness resulted by directing the fluid lengthwise down the airbox. From a practical standpoint, the installation of nozzles in the airbox was not particularly satisfactory due to their tendency to plug with carbonaceous matter. Puddling of starter fluid in the airbox was also somewhat of a problem when applied in this manner.

Locating the starter fluid nozzle in the center of the airstream on the discharge side of the blower was less effective than the locations described above. Presumably this was due to the lower velocity of the air flow at this point. The area of the discharge side of the blower was approximately four times that of the air intake pipe at the air cleaner. The servicing of a nozzle installed at this point would be most inconvenient since it entails removal of the blower.

The introduction of cold starting fluid at either of the two points on the suction side of the blower was deemed least satisfactory of the several locations investigated. One of the reasons for this was the tendency for some of the fluid to puddle in the bottom of the blower housing. This necessitated the use of a greater quantity of fluid for starting than was generally required at the other points of introduction. This difficulty was most pronounced at temperatures below 10 F. The lower the temperature the more serious was the problem. The difficulty was encountered irrespective of the type fluid employed.

Presumably these two nozzle locations were too close to the blower inlet to permit intimate mixing of the vaporized fluid and air. As a consequence the fluid entered the blower in a stratified non-homogeneous state. Instead of furthering mixing as might be expected it is theorized that the blower actually acted as a centrifuge that threw the unmixed fluid vapor against the walls of the blower where it condensed and ran down into the bottom of the housing.

The accumulation of a substantial quantity of raw starter fluid in the blower case at sub-zero temperatures can cause trouble due to rapid vaporization of the fluid as the engine warms up. As a consequence there may be a tendency for the engine to run out of control during the warm-up period, particularly if the equipment should be left unattend-

ed, unless governed or protected by the proper safety devices.

Methods of Starter Fluid Application

Five methods of starter fluid application have been given study. These are:

1. Low pressure, aerosol method of application.
2. High pressure injection of bulk fluid.
3. Pressurized capsules.
4. Hand primer using either gelatin capsules or bulk fluid.
5. Carburetion.

These methods were evaluated over a temperature range of +40 F to —38 F. The same fluid was used in all cases. Comparisons were made on the basis of: (a) quantity of fluid used, (b) rapidity of start in seconds, (c) lowest temperature at which applicator could be used to give valid starts using cold fluid soaked to the same temperature as the engine equipment. The interpretation of a valid start varies with different investigators.

A valid engine start as herein implied represents that quantity of starting fluid required to start an engine and keep it running until it is able to run on its regular fuel. By this interpretation the first fire does not necessarily constitute a start unless the engine continues to run.

There seems to be a generally prevailing opinion that the sole requirement of a starting fluid applicator is effective atomization. Although this is a very essential characteristic it accounts for only a portion of the application problem.

Application technique is every bit as important in cold temperature starting as a high degree of atomization. All five of the applicators studied did an excellent job of fluid atomization, yet their performance could be made to vary widely simply by changing the technique of using them. Herein is believed to lie the difficulty frequently encountered in starting engines on starting fluid. The proper technique is not used.

The term applicator technique has been given to the procedure that is required for introducing starting fluid into an air induction system of an engine in order to secure a positive start. This procedure involves several considerations that are as follows:

1. Quantity of fluid used.
2. Rate of fluid injection.
3. Duration of injection.
4. Atomization.

Quantity of fluid used, rate of fluid injected and duration of injection are influenced by engine type and size as well as by the temperature level of the start.

Proper application technique as regards items No. 1, 2, and 3 may be achieved in two ways. These are as follows: (a) manual manipulation of the applicator by the operator and (b) by incorporating the necessary technique within the design of the applicator itself.

Successful manual manipulation of an applicator for consistent low temperature starts requires some experience on the part of the user. He must be fairly familiar with the starting characteristics of the engine being started and also possess some knowledge of how the starting aid should be injected with the equipment used. Frequently an experienced operator learns the proper application technique for his equipment by trial and error. An applicator with the starting technique engineered into the design may be used successfully by relatively inexperienced personnel with a few simple instructions. Methods No. 2 and 4 represent examples of applicators requiring experienced manual manipulation to achieve satisfactory starts. Methods No. 1 and 3 are examples of application where technique is automatically taken care of to a high degree. Method No. 5 lies in a category somewhere between the manual and automatic types as some experience may be required for its successful use.

Studies to date indicate that fluid quantity for positive starts tends to vary with engine type and size as well as temperature. For example, a single-cylinder, four-cycle engine of 38 cu in. displacement may require only 5 cc of fluid for a 5-sec start at —20 F whereas a 210-cu in., two-cycle engine may need as much as 35 cc of cold fluid for a 10-sec start at the same temperature. At +20 F a start can be made on the four-cycle engine in 5 sec or less using only 3 cc of fluid. The two-cycle engine can be started in about the same time with approximately 8 cc of fluid.

The rate at which the fluid is injected together with the duration of injection also varies with engine type and size. The influence of temperature on rate of injection for any particular engine is not quite so critical over a temperature range of +40 F to —25 F. Generally, the same rate can be used throughout this range, although duration of injection may vary due to the vaporization characteristics of the fluid. The rate pattern for effective injection of starting fluid is about the same for all applications regardless of engine type or size. The fluid must be injected at a high initial rate during the first second or two of the application. Following this the rate must be tapered off gradually until the regular fuel takes over. Obviously this takes more time at low temperatures than at high.

A positive type of applicator that contains the necessary features for automatically starting an engine at low temperatures by inexperienced personnel is an important one. Usually an operator has one chance and only one chance to start his equipment at below —15 F if cranked electrically. This is during the first 5 to 10 sec of cranking when maximum energy is available from the battery. Should an operator muff a start during this period it is unlikely that he will succeed in getting started at all. Applicator No. 1 (low pressure, aerosol), represents a type that assures positive engine starts by inexperienced personnel to a high degree. It was the best applicator tested in this respect.

The high-pressure manual injector, the pressurized capsules, and the hand primer using either gelatin capsules or bulk fluid were likewise effective applicators. All of them, however, required somewhat more experience and entailed more trouble for successful use than did the low pressure aerosol applicator. Only limited study has been given the carburetion method. Enough work has been done on this device to indicate that if it were properly engineered it might well prove a low cost as well as effective method of application. Somewhat more experience would be required for its operation if manually operated due to the need for proper manipulation of a choking mechanism which cuts off part of the air supply to the air intake of the engine in order to supply a small amount of high-velocity air through the venturi of the carburetor.

On the basis of the experience gained to date on the application of starting fluids at low temperatures a satisfactory applicator for the purpose should possess the following features:

1. Rugged and reliable over a temperature range of +40 F to —65 F.
2. Adaptable to all engine sizes and types without major modification.
3. Suitable for portable or permanent installation.
4. Controls must be of ample size for manipulation with gloved hands.
5. Mechanism for complete operation of applicator must be incorporated within the unit.
6. Application technique should be designed into the unit for successful use by inexperienced personnel.
7. Readily serviceable.
8. Safe under all operating conditions. Unit should not be operable during normal engine running.
9. Applicator should be self-priming so that it is ready to use at all times.
10. Installation should be relatively simple.
11. Unit should be reasonably priced and cost of operation low.

Effectiveness of Starting Fluids

On the basis of the observations made it would appear that the limit of effectiveness of currently available starting fluids is between —25 F and —30 F. This is for cold fluid soaked to the same temperature as the test equipment.

It is possible, however, to obtain engine starts at still lower temperatures with these starting fluids by raising the fluid temperature. For example, starts down to —40 F have been obtained on the 2-cycle engine using ether fluid that had been warmed to a temperature of approximately +60 F. Comparable starts have been obtained with other types of fluids also.

Usually at sub-zero temperatures below —25 F the major difficulties in starting are due, not so much to the ineffectiveness of the starting aid, but to other factors such as batteries, cranking motors, injection equipment, valves, air induction system icing, etc. The difficulties caused by such factors frequently nullify any advantage that may be afforded by the use of a starting fluid. Failure of equipment to operate properly at such temperatures is a strong argument for supplementary equipment that will sup-

ply some heat to engines that must be started under these severe conditions. The beneficial use of a starting aid represents only part of the overall problem.

No matter how effective the starting fluid, starts of less than 4 sec on multi-cylinder engines ordinarily cannot be expected throughout a temperature range of +40 F to —10 F. This is due to the physical delay involved in the flow of the fluid vapor from its point of atomization to the engine cylinder. Two-cycle engines appear to require somewhat more time for the fluid vapor to reach the cylinders than do four-cycle engines. This is apparently due to differences that exist between the air induction systems of two- and four-cycle engines. At temperatures below —10 F the inherent effectiveness of starting fluids tend to show up. The lower the temperature the greater the difference. As stated above, however, the limit of effectiveness of cold fluids appears to be reached somewhere between —30 F and —25 F. The importance of application and application technique becomes more significant at such temperatures also. In order to obtain starts of 10 sec or less with minimum quantities of fluid at these temperatures the combination of fluid, applicator, and application technique must be given careful consideration.

In the case of the four-cycle, single-cylinder engine certain peculiarities have been noted. The minimum temperature at which this engine could be started on diesel fuel alone was +35 F. Even at this temperature considerable time was expended to effect a start. Using a minimum quantity of starting aid, this engine became one of the easiest to start at all temperatures down to –25 F, the limit of the current study on this engine.

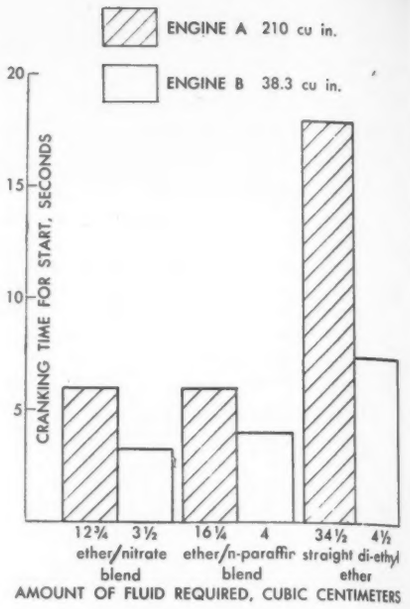
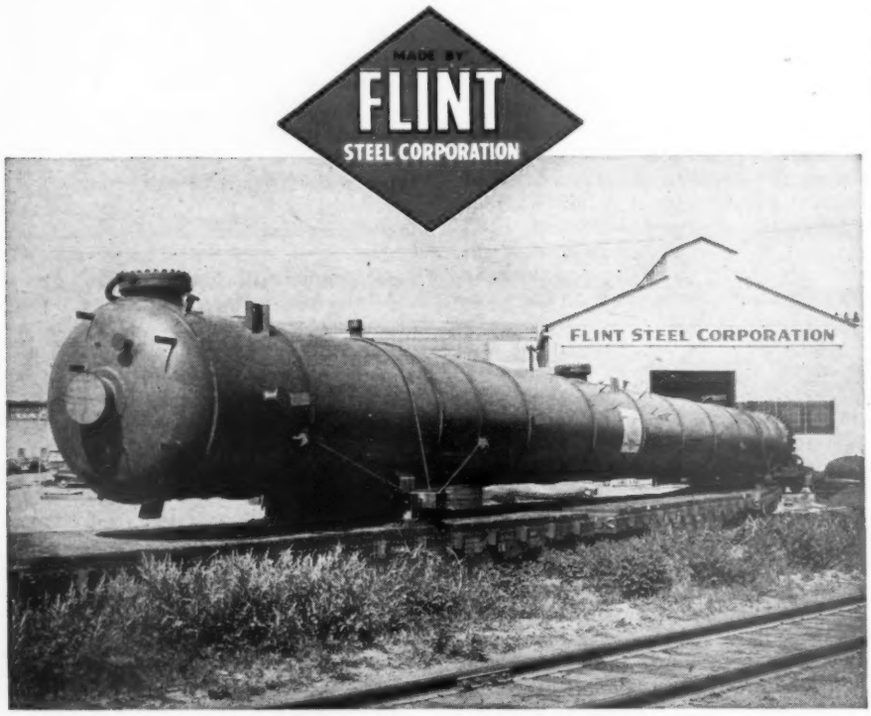


FIG. 7. Starting fluid effectiveness at minus 14±2 F.

Chart 7 shows the starting effectiveness of three types of fluids that have been given considerable study. All fluids were of the ether type. The percentage of ether contained in the nitrate, however, n-paraffin blends was less than 25 per cent. As will be noted these particular data were obtained at –14 F using an applicator similar to that described as Applicator No. 1 above under Methods of Application. Starting data are shown for both the 210 and 38.3 cu in. engines. Cranking speeds for engine A ranged between 120-130 rpm. The range of cranking speed for engine B was between 320 and 330 rpm. The data were obtained after the equipment as well as starting fluid had been soaked at the test temperature for a period of 22 hr. The greater effectiveness of the n-paraffin-nitrate blends for positive engine starts will be noted. Straight diethyl ether was found to give very rapid ignition but sustenance of steady firing was more difficult. This failure to sustain combustion until the regular fuel takes over accounts for the somewhat greater quantity of fluid required at this temperature.

The development of starting fluids that will be inherently effective at temperatures down to –65 F represents a challenging problem. It is believed, however, that as more information is accumulated on why starting aids behave as they do it may be possible to formulate a starting aid in which the various desirable performance qualities are accentuated to a high degree. ★ ★ ★



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PART 7—Installation and Maintenance

CHARLES F. JOHNSON, JR.*

The Dynamaster series of instruments, in both the round-chart and the strip-chart forms, may be mounted on a wall or flush on a panel. Although the instrument is exceptionally resistant to the effects of dust, dirt, vibration, and extremes of temperature, it is always wise to locate it as remotely as possible from unfavorable influences. It should be oriented so as to be easily observed by and accessible to personnel who will use it or who will be responsible for replacement of charts and other attention.

Actual installation of the Dynamaster instrument is relatively simple. The chief consideration is that there should be sufficient clearance allowed between it and other instruments or equipment on the wall or panel to permit full opening of the case door and easy access to the bottom of the case for wiring and piping connections, as required. Although there is no operational reason for observing the exact leveling of the instrument, reasonable care in this respect will improve the swinging action of the case door and of the instrument panel.

A principle sometimes overlooked in the installation of electrical measuring instruments is that the lead wires of the measuring circuits should never be placed in the same conduits with electric power-lines of any sort.

When air-operated controls are included in the instrument for actuating valves or other process devices, piping or tubing will be required. Case connections are provided in the bottom of the instrument for standard ¼-in. pipe or ⅜-in. copper tubing.

The chart-retaining apparatus of both the round-chart and strip-chart instruments is simple but thoroughly reliable and positive in action. On the round-chart model, the chart is replaced merely by grasping the indicating pointer by the hub and, after pulling it away from the central driving-arbor, swinging it to the left out of the way. A new chart-roll is placed in a strip-chart instrument by first swinging out of the way the hinged chart-plate and then fitting the new chart-roll into the loading spindles and feeding the end of the chart strip around two guide rods, over the feed-roll at the top of the instrument, down across the closed chart-plate and finally wrapping one or two turns of it around the rewind tube mounted between the spindles at the bottom of the instrument panel.

Round-chart and also the one and two-pen strip-chart Dynamasters use the fountain-pen method of recording. Before attempting to use such instruments for the first time, it is necessary to fill the pens with ink of the desired color, and in doing this, it is always preferable to use the type of ink manufactured by the instrument maker for that particular combination of pen and chart paper. Multi-point Dynamaster recorders are supplied with properly-inked felt pads already installed in the print-wheel mechanism, and under conditions of ordinary service, the supply of ink in these pads is adequate for legible printing throughout several months of continuous operation.

Wide-strip potentiometers that do not include the constant-voltage unit must have installed in them a 1½-v dry-cell as a source of supply for the potentiometer circuit. This cell must be wired into the circuit and manually standardized. Thereafter, standardization will be completely automatic, and the cell will need to be replaced or checked only about once a year. Manual standardization of this type of instrument is required only when starting up for the first time, or after installing a new battery.

Maintenance Procedures

In every respect, the numerous design-features of the Bristol line of instruments have been worked out so as to require a minimum service due to failure or excessive wear of components, or the need for electrical or mechanical readjustments. Because completely satisfactory service work on electronic recording instruments requires thorough familiarity with all their mechanical and electrical complexities, the manufacturer usually recommends that anything other than general routine maintenance should be done by qualified instrument technicians, or that the instrument should be returned to the maker for servicing. With the Dynamaster type of instrument and its easily accessible building-block arrangement of components, however, it is possible through a series of very simple tests to check for the cause of faulty operation and track it down to the basic unit concerned, which may then be easily replaced. Thus, the sensible thing to do whenever trouble develops is to refer to the standard routine checking procedure for general trouble-shooting, as described in what follows here and also in more complete detail in the Dynamaster instruction book.

Routine preventive maintenance or careful supervision of the instrument at regular intervals will forestall most troubles by bringing systematic attention to bear on important details. This involves, for example, the following of lubrication schedules, the stocking of a reasonable minimum of spare components, and the assigning to one selected individual of the responsibility for providing routine care of the instrument.

Lubrication of the Dynamaster is simple. For the round-chart and the single-point strip-chart models, the principal items requiring attention are the front and rear bearings of the balancing motor and the center arbor of the round-chart mechanism. These need only a few drops of light-bodied electric motor oil about four times per year. The multiple-point instrument requires, in addition to this, lubrication of the print-wheel assembly and switching mechanism approximately once a year, and oiling of the front and rear bearings of the selector-switch motor. The selector-switch contacts should be cleaned occasionally with carbon tetrachloride and lubricated with a thin film of vaseline. All other bearings of these instruments are designed either to run dry, in which case they should merely be kept clean, or to be permanently sealed and require no lubrication during normal life.

If the instrument is of the potentiometer type and uses a dry-cell as the bridge voltage-source, periodic replacement of this cell should be set up as part of the routine maintenance schedule. The standardizing mechanism of the instrument carries a signaling device which shows red when the dry-cell becomes seriously weak, as may occur in normal service within a period of six to twelve months.

The chart and pen or print-wheel mechanisms of the Dynamaster instruments have been designed to operate with a minimum of attention over long periods of time. A number of adjustments, however, are provided, including chart feed alignment, feed and rewind clutch friction, and replacement of pen or print-wheel drive cord.

*Application engineer, The Bristol Company, Waterbury 20, Connecticut.

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Trouble-Shooting

When a Dynamaster instrument fails to function properly and the fault is not immediately obvious, usually the quickest and most satsifactory method to follow is, first, to check the electrical supplies, and then if this does not disclose the trouble, to replace several of the easily-removable components one at a time. This "replacement" method of service will cover most difficulties with a minimum of time and expense, and can be used by relatively inexperienced technicians. Whenever the trouble cannot be located by this method, however, it is recommended that the job be handled only by a qualified instrument service man, or by the manufacturer.

Replacement parts to be kept on hand for the purpose consist of one complete set of electronic tubes, one plug-in type electrolytic filter capacitor, and one complete amplifier. Assuming, then, that a Dynamaster has become inoperative and that a preliminary check has shown that the electrical supplies are all right (including the a-c line power and fuses, the measuring element and its connections, and — on potentiometer instruments not equipped with constant-voltage sources —the 1½-v dry-cell and the standard cell which are used in the automatic standardizing circuit), the procedure is to check the following components by replacing them with units known to be good:

1. **Electronic Tubes.** Even though the tubes light up, they may not be operating correctly. They should be replaced one at a time, with a sufficient interval allowed for warm-up after each replacement. After changing any of the tubes, the amplified gain-adjustment should be checked in accordance with suggestions below. If the instrument still does not function correctly, the new tubes are to be left in the amplifier, and testing should proceed with replacement of the plug-in-type electrolytic filter-capacitor.

2. **Electrolytic Filter Capacitor.** Replacement of this unit should be followed by a recheck of the gain adjustment on the amplifier as explained in No. 4 below.

3. **Amplifier.** If replacement of tubes and capacitor fail to produce satisfactory operation, the final step in the simplified method of trouble-shooting is to replace the entire amplifier. In doing this, all wires are disconnected from both terminal strips of the amplifier unit, which is then easily removed by loosening the rear mounting screws and unlocking the quick-fasteners at the front base of the chassis. The new amplifier is next installed and carefully reconnected, following which a check is made of the gain-adjustment.

4. **Amplifier Gain-Adjustment.** To prepare for this phase of the work, the amplifier should be allowed to warm up for at least two minutes, and the measured variable affecting the primary sensing element should be kept at some steady value. Upon turning the balancing-motor pinion or drive gear manually to the right or left and then releasing it, the print-wheel or pen should return to its original position. If it does not do this completely and quickly, the inference is that the amplifier sensitivity is low, and the gain should therefore be increased. This may be done by removing the protective cap from the gain adjusting-screw, and turning this screw until the print-wheel or pen responds quickly when the balancing motor is manually shifted away from the balance point and then released. If the amplifier gain happens to be too high, the instrument will probably "hunt;" i.e., the pen or pointer will go into sustained mechanical oscillation in the vicinity of the balance point, in which case the gain control should be turned back.

The "symptomatic" method of trouble-shooting, which some instrument men prefer, works quite well for relatively simple troubles. Three major symptoms may be considered:

1. If the pen or print-wheel remains stationary, regardless of changes in the value of the measured variable, the trouble may be:
   - **a. Defective line fuses.**
   - **b. Power failure.**
   - **c. Defective amplifier fuse. An amplifier which burns out repeatedly generally is an indication of a bad rectifier tube or filter capacitor.**
   - **d. Defective tube in amplifier.**
   - **e. Defective filter capacitor.**
   - **f. Open circuit in measuring element.**
   - **g. Syncroverter failure.**
   - **h. Defective balancing motor.**

2. When the pen or print-wheel records incorrect values or oscillates back and forth, the trouble may be due to:
   - **a. Defective measuring element.**
   - **b. Weak battery (in potentiometers).**
   - **c. Defective standard cell (in potentiometers).**
   - **d. Defective standardizing mechanism (in potentiometers).**
   - **e. Insufficient multiple-switch operating spring-tension.**
   - **f. Amplifier gain-adjustment set too high.**

3. If the chart does not feed properly, the possible faults are:
   - **a. Chart not lined up properly.**
   - **b. Clutch slipping.**
   - **c. Chart-drive defective.**
   - **d. Line frequency incorrect, causing synchronous chart-drive motor to operate chart at incorrect speed.**

Whenever the replacement or symptomatic methods of trouble-shooting fail to disclose and correct any defect, a systematic check should be made of all components of the Dynamaster system by a qualified instrument service man. The most effective way of carrying out this analysis is to start with the recording system and work back through the balancing motor, amplifier, syncroverter, switching mechanism (in multiple-point recorders), and potentiometer circuit.

The recording system is mechanical and includes the chart-drive, gear train, chart feed-roll, pen or print-wheel assembly, pen or print-wheel cord pulleys, and all other parts incident to the mechanical operations involved in recording. Trouble-shooting here involves principally an inspection for looseness or binding of gears, pulleys and other moving parts or fittings.

The balancing motor is a two-phase induction-type, in which one winding, usually referred to as the "reference" winding, is constantly energized from the a-c power line. The other, or "control" winding is fed with an a-c only when an error-signal comes from the measuring circuit via the electronic amplifier. The phase of the inverted and amplified error-signal in this control winding lags the reference voltage by 90 deg when the measured variable (input) decreases, thus causing the motor to drive the pen or print-wheel downscale. Whenever the measured variable increases, the input polarity reverses and the error-signal leads the reference voltage by 90 deg, thereby causing the motor to reverse and drive the pen or print-wheel upscale.

The motor is readily tested by removing the two control-winding lead wires from the motor terminal strip and reconnecting these wires to the line-voltage terminals on the same motor terminal strip. With the instrument power-switch turned on, the motor should then move the indicator or pen up or downscale. Upon interchanging the control-winding lead wires to the same two line-voltage terminals, the motor should then go in the direction opposite to that in which it previously rotated.

Before proceeding to a check of the amplifier, it would be best to have first gone over the voltage supply, fuse, tubes, filter capacitor, and balancing motor, as already discussed. In other words, it is wisest from the standpoint of time and expense to trace the difficulty back to the amplifier through a step-by-step elimination of other possible sources of trouble, rather than to try to run detailed tests on the amplifier at the outset.

Test equipment required for service checking of Dynamaster amplifiers consists of only two items: (1) a multirange volt-ohmmeter with a sensitivity (input resistance) of not less than 1000 ohms per volt, and with ranges of 0 to 50, 0 to 500 v d-c, 0 to 4000 and 0 to 500,000 ohms, and (2) a microvolter (such as the Bristol "Dynaprobe") for producing either a d-c or 60-cycle a-c test input signal. The Dynaprobe test signal generator has been designed to provide either 3 mv d-c or 30 mv a-c at the test prongs, depending on the position of a push-button switch.

To run a preliminary check on the amplifier as a unit, the lead wires are removed from the input terminals, and wires are run from the test signal generator to these points. After the instrument switch has been turned on and sufficient time has elapsed for the tubes to warm up, any test signal of approximately 10 microvolts or more will cause the balancing motor to move the pointer up or downscale, if the amplifier is operating correctly. If this preliminary check shows that the amplifier is defective, it may easily be removed from the Dynamaster case by disconnecting all wires from the two terminal strips,

loosening the rear chassis mounting-screws, and unlocking the front quick-fasteners.

Checking of components inside the amplifier unit of the Dynamaster instrument should not be attempted by the average user. Service work on electronic circuits is a specialized technique requiring knowledge and experience not commonly available among instrument operating men. For this reason, unless an electronic technician is available, a defective Dynamaster amplifier should be replaced as a unit with a new one and then returned to the manufacturer for checking and repair.

For users having electronic service engineers and suitable test facilities, The Bristol Company offers a complete set of instructions containing a detailed circuit diagram, testing data, and procedure for checking the various components of the Dynamaster amplifier.

Assuming that no causes for the operational fault can be located in the recording system, balancing motor, or amplifier, the next point of the testing procedure is to use an ohmmeter for proving continuity of each of the two windings of the input transformer. The probability that this component will develop troubles is quite small as there is little chance for it to be subjected to damaging current.

Proceeding from the input transformer, the next unit found in Dynamaster potentiometers (but not usually in Dynamaster bridges) is the Syncroverter, the vibrator-type reversing switch which is completely enclosed within a hermetically-sealed housing. With the instrument power-supply switch in the "On" position, disconnect the lead wires from the potentiometer circuit to the Syncroverter at the Syncroverter terminals, and apply a source of direct emf (about 2 mv) across these terminals. When the converter unit is functioning properly, this test will result in movement of the pen or print-wheel up or downscale. For reversal of the polarity of the test d-c voltage, the recording system should move in the opposite direction. Correct response at this point in the test procedure shows that the Syncroverter, input transformer, amplifier, balancing motor, and recording system are operating satisfactorily.

The automatic mechanism providing the necessary mechanical power for printing in the multi-point dynamaster, as well as for sequential selection of all the primary measuring circuits has been carefully designed and manufactured for long and continuous service. Occasionally, however, an instrument may develop a tendency to print at random some or all of the records on the chart, a condition caused by insufficient tension in the multiple-switch operating spring. To increase this tension, it is necessary only to move the spring adjusting link to the next hole in the series provided for that purpose.

The electronic potentiometer type of Dynamaster uses a null-balance circuit. The primary measuring element (thermocouple, etc.,) is connected in series with certain elements of this circuit, the Syncroverter contacts, and the primary winding of the input transformer. This means that an "open" anywhere in the measuring circuit, slide-wire, Syncroverter, or primary of the input transformer will produce the same result; i.e., no d-c error-signal in the circuit, and consequently no output from the amplifier to the balancing motor.

In the bridge-type instrument, the measuring element is wired so as to form one leg of the bridge. Thus, an open circuit in the measuring element, associated lead wires, or bridge will produce an infinite resistance, driving the pen or print-wheel to the top or bottom of the instrument scale, depending upon what portion of the bridge is open-circuited. If an "open" is suspected, it may easily be checked with an ohmmeter. If not isolated in the measuring element or its leads, the fault may exist in the bridge-supply transformer (8 to 9 v secondary winding), the output of which may be checked with a suitable a-c voltmeter. A final point to check would be the sliding contact of the slide-wire. Carbon tetrachloride may be used as a cleaner for the slide-wire, followed by a light application of vaseline.

Other items that may easily be checked with an ohmmeter when the cause for faulty operation of either a potentiometer or bridge-type Dynamaster is not made apparent from the preceding testing programs are the various resistance spools, switch contacts, and wiring within the instrument. In checking with an ohmmeter the circuitry of Bristol potentiometers, the chief caution to be observed is that the meter should never be placed across the measuring-element terminals in the instrument or across any of the terminals of the Syncroverter unit. The reason for this is that the relatively high current drawn by most types of ohmmeters may damage the precisely-adjusted contact arrangements of the Syncroverter.

Part 8 of this series on instrumentation will be published in an early issue.

Control Equipment

The Dynamaster series of instruments is offered with both electric and air-operated systems for controlling process equipment. Electric Dynamaster controllers are available in three varieties:

a. The on-off or multiple-contacting type, with from 1 to 4 control switches.

b. The proportional current-input type, with a proportional band adjustable from 2 to 8 per cent of full range of the instrument.

c. The proportional type, available with 10 and 15 per cent proportional bands.

These models cover practically the whole range of applications for electric-type automatic control, including on-off, two-position, three-position, floating, proportional, and current-input control. They can be used with all types of motor and solenoid valves, electric contactors, automatic feed devices, and for alarm and signaling purposes. The control point is adjusted by means of a knob on the inside of the case, which simultaneously positions the control device and a movable indicator on the scale of the instrument. The control adjustment-knob is also furnished for operation on the outside of the case, if desired.

Air-operated Dynamaster controllers are offered in five different models for either reverse-action or direct-action control:

a. On-off,

b. Proportional, adjustable from 0 to 30 per cent or from 0 to 100 per cent,

c. Reset, having a proportional band adjustable from 0 to 50 per cent, and a reset rate adjustable from 0 to 0.75,

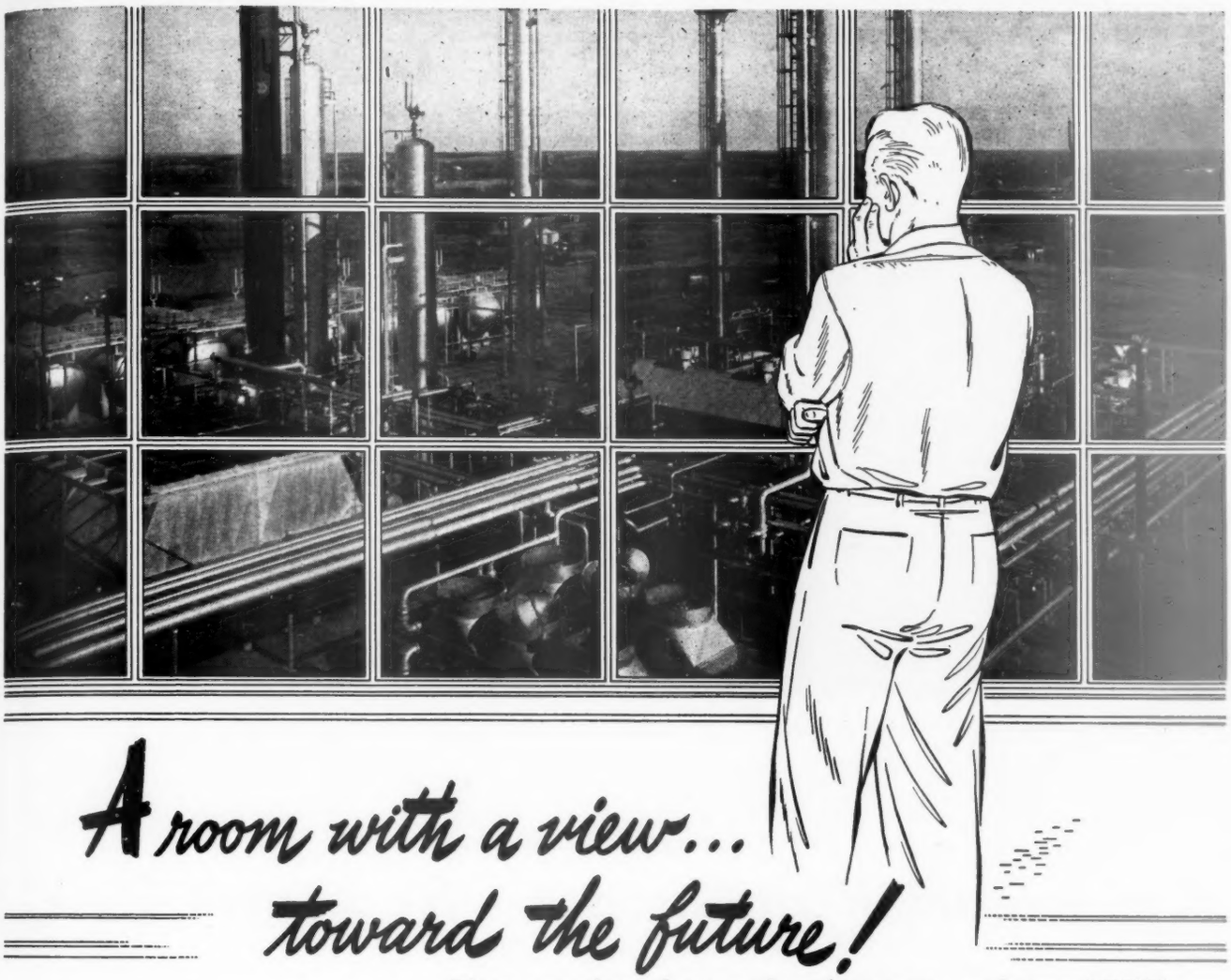
d. Derivative, having a proportional band adjustable from 0 to 100 per cent, and a derivative time-adjustment covering from 0 to 5 min,

e. Reset-plus-derivative, having a proportional band adjustable from 0 to 150 per cent, a reset rate adjustable from 0 to 0.75, and a derivative-time variable from 0 to 5 min.

All adjustments of these several models are easy to make and are capable of being set for quick and accurate reproducibility. The pneumatic control devices operate from 20-psi air supply regulated by a precision pressure reducer having a minimum air consumption. As with the electric controller models, the control point is adjustable by means of a knob which may be located either inside or outside the case.

An additional feature available for the air-operated Dynamaster controllers is the manual-automatic station, a device which makes it possible to switch between automatic and manual control and to shut off all air connections to the control unit for servicing and testing.

The Dynamaster series of instruments and associated control devices have been engineered and manufactured not only to provide high accuracy and dependability in operation, but also to provide easy accessibility to all major components for routine maintenance or rapid trouble-shooting and replacement of basic parts. Each unit of the instrument can be serviced without disturbing any other parts. Mechanical and electrical maintenance are at a minimum because of general ruggedness of construction, the small number and functional design of moving parts, and the operation of electrical circuit-elements well within their continuous-service ratings. All these features, together with the ease with which the Dynamaster instruments may be adapted to a wide variety of uses, have created large demand for them among process designers and instrument supervisors throughout industry as well as in research and development laboratories, private and governmental. ***



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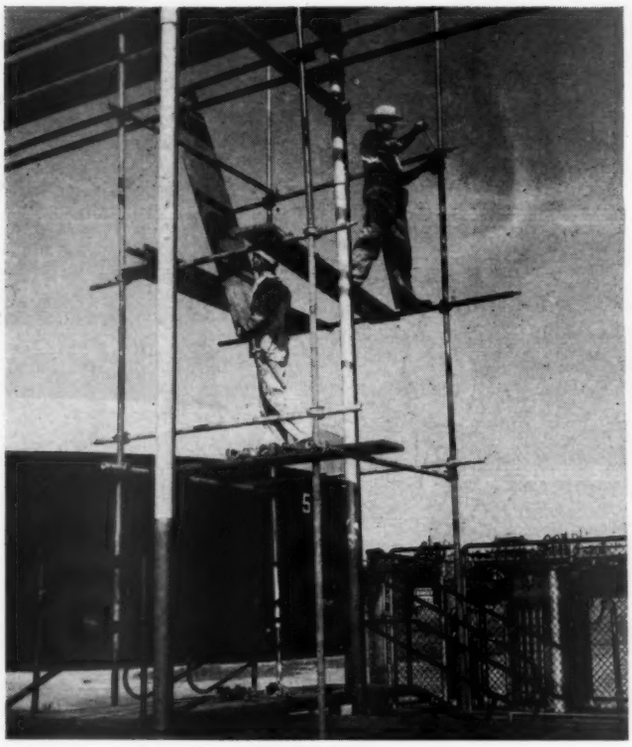
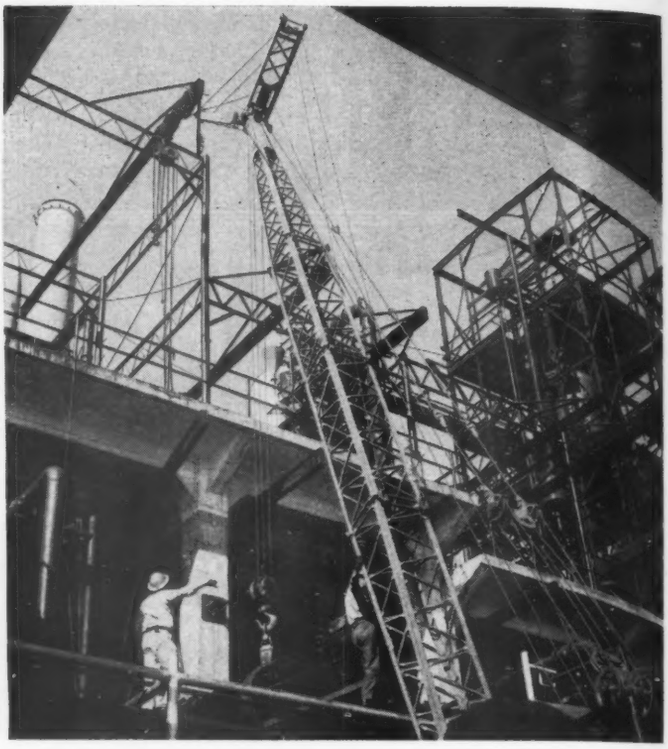


Erecting metal scaffold for piping repairs.



Raising exchanger bundle to shell location.

On-Stream Maintenance—What and How‡

Competent supervision and scrupulous attention to detail are musts in this field

J. O. THOEN* and LLOYD G. FOSTER†

In a well-planned refinery maintenance program, the character and scope of work during on-stream periods may differ materially from that done during turn-arounds. In general, however, the form of organization, the system of planning, and the application of methods and standards are essentially the same. The difference lies largely in the conditions under which the work is done.

On turn-arounds it is essential that the work be planned for the minimum down time. Adequate manpower must be assigned to get the work done within the specified time. Planning for efficient performance must be done without resorting to omissions, substitution, or postponement of any part of the work necessary as part of the turn-around.

In the case of on-stream maintenance, the time element applies to a lesser degree. Much of the work can be fitted to the available manpower in planning the daily schedules. This allows a certain amount of flexibility but also involves on the part of planning more long-range considerations.

Type of Equipment and Work

The on-stream maintenance activities in connection with the unit proper should be concerned with, first, the repair work which can be completed after the unit is back on stream and, second, preparatory work and prefabrication for the next turn-around.

In the first category will be found spare units such as pumps, drivers, and sometimes exchangers or coolers that can be repaired in place or removed to the shops for reconditioning and reinstalled while the unit is on stream.

Other equipment of the same type may not be indispensable at all times or may not be in continuous operation. These items and certain valves, lines, and instruments of the same status can be serviced on the on-stream basis. Still further removed from the basic functioning of the unit are such necessary maintenance items as paving, insulation, painting, structural work, lighting, and other utility systems.

The second category consists of the

The Authors

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†Senior industrial engineer, manufacturing department, Continental Oil Company.

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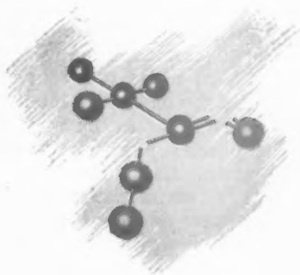

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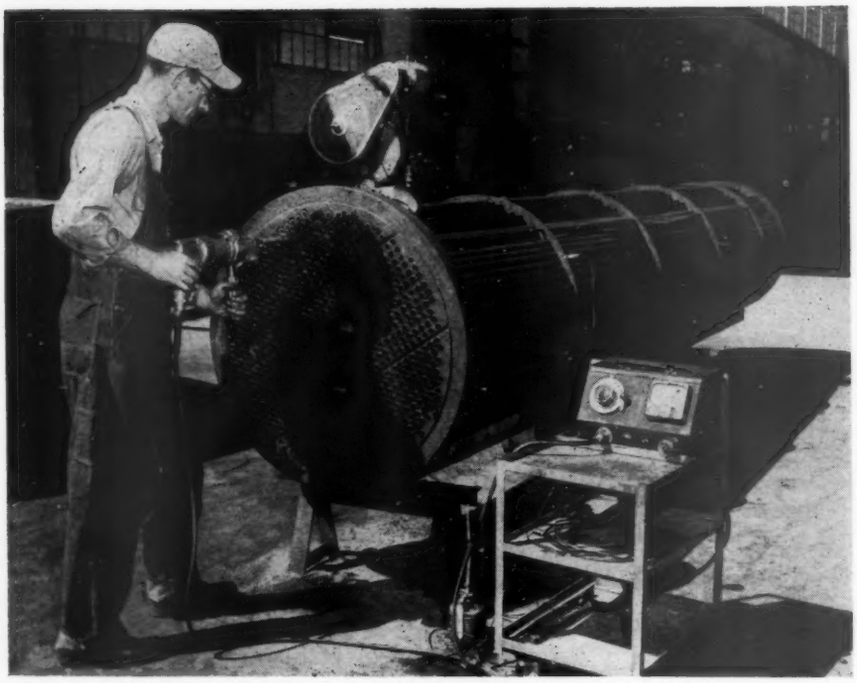

Final rolling of tubes in repaired exchanger bundle.

work of fabrication of and preparation for jobs which inspection indicates should be done during the next shutdown. This applies particularly to such items as are found to be subject to relatively uniform wear or corrosion, the progress of which can be plotted and extrapolated so that fairly accurate estimates can be made of the end point of safe usage. Typical examples are piping, furnace tubes, exchanger bundles and shells, pump rotor assemblies, internals for towers and other processing vessels.

The aim should be, therefore, to limit as far as possible the work of the turnaround to installation of equipment that has been made ready in every respect during the on-stream interval.

In addition to the work required for the process units, the maintenance department has, of course, a sizable work load in maintenance of general plant equipment and facilities. This is a great variety of work that from the standpoint of planning and availability is of at least four general classifications.

1. Operating equipment that is in noncontinuous or only part of which is in continuous operation. This group includes treating, blending, packaging, and loading plants, and certain utilities.
2. Continuously operating equipment that can either be partly or completely shut down temporarily whenever men are available. The more important of these are the general utilities such as the plant air, cooling water and power distributing systems.
3. Equipment that is generally available at any time. This includes buildings, grounds, sewers, shop equipment, and mobile equipment.
4. Considerable work that is not properly classed as repairs still is part of the maintenance program, including cleaning of operating equipment and loading and unloading of supplies and materials.

The maintenance department is also called upon to do construction work whenever the size and scope of a project of this classification do not warrant setting up a separate organization with independent supervision and control.

As all these varied activities constitute the general on-stream maintenance program, any system for effective performance must take them all into account.

Cost Control

The maintenance department's primary task is to see that the work is done when needed, but it also has as a major responsibility the function of cost reduction in its field. For this objective the variety of measures to be taken can be classed broadly under two heads. One is a program of preventive maintenance that seeks to reduce the frequency as well as the extent of the jobs. The other program would have as its objective the maximum efficiency and economy in the performance of the work.

Preventive Maintenance

Preventive maintenance requires the attention and efforts of practically all line and staff groups in the refinery. Its control must therefore be a function of the refinery management itself. All the possibilities of preventive maintenance are rarely completely explored. This seems to be because so many phases of and opportunities for preventive maintenance are not recognized as such.

If the need for proper co-ordination is appreciated, a fairly definite plan with specific procedures can be formulated. Such a plan if carefully followed through could be regarded as a starting point for the development of every phase of improvement possible in the maintenance program.

It can be safely said that preventive maintenance begins on the drawing board where the plants are designed. The selection of materials, the design of equipment, its location and spacing, provision of working platforms or other means of access, and use of instruments whenever they can be helpful in disclosing and interpreting faulty conditions are some of the things the designer should consider from a preventive maintenance angle. Another important feature is the installation of spares where they will serve not only as insurance against shutdowns but to allow periodic inspections at the proper time to avoid major repairs.

The next activity in the order of sequence is the care taken of equipment by the operators. High maintenance costs can be prevented by avoiding over and underloading and fluctuations in control, especially temperature conditions; by careful lubrication and servicing; and by alertness to signs of trouble. The latter may require the use of most of the senses but particularly sight and hearing, unaided or with the help of the instruments mentioned above.

That part of the preventive maintenance program that is most productive of results is also that involving the most work. This is the system of periodic inspections, an important part of which is the keeping and analyzing of records of the inspections and repair of equipment. Such a system requires considerable study. The different types of machines and equipment will vary greatly in the optimum length of intervals between inspections. The aim is to prepare a definite schedule for all equipment, a schedule from which nothing can be omitted without risking high maintenance costs. At the same time the scope of such inspections as well as their frequency should be held to a minimum in order to reduce loss of operating time and ineffective labor to the minimum. This effort becomes a continuous process. Constantly, if good records are kept, there will be reason to add and delete items, changing the interval or changing the scope of the inspections.

One part of the inspection program is the daily work of observation and adjustment on the part of mechanics who are skilled in the knowledge of the particular machinery or equipment they are assigned to watch. They may tighten packing and check lubrication, motor temperatures, and pump speeds, voltages, pressures, and surrounding conditions that may be harmful to the equipment. These men, like the operators, should be alert to any unusual condition and should either correct it or call it to the attention of the supervisors. In this respect, there is some common responsibility on the part of the operator and the mechanic; and close collaboration between them is essential.

The technical staff, particularly the corrosion engineers, has an important place in preventive maintenance. As a large proportion of maintenance involves the problem of loss or failure of metal, the continual application of corrosion and metallurgical engineering studies is indispensable. It should be assumed that there is a possible preventive measure

Valve repair shop showing valve testing station in rear.

for every case of corrosion, erosion, abrasion, and fracture. By studying the facts involved and analyzing the cause of the failure, the technologist by application of his specialized knowledge can often indicate the remedy. He thus becomes a direct aid to the designing engineers as well as the maintenance department.

Other staff groups, such as process engineering, laboratory, and research, can often contribute materially to the preventive maintenance program. The possibilities are so wide and varied that it cannot be said that any list of activities comprises all that such a program requires. In the end, however, someone must study all the records and reports of costs and performance from the broad standpoint of seeing what has been done in the past and how such information can be used for future improvement. Again it is desirable to have a minimum number of reports and only such detailed information as is of value. Completeness is in itself a necessary element in any record or report; but the system should be so designed that outstanding items, good or bad, can be plucked from the whole for the attention of the supervisors or staff member responsible for their control. Unless a satisfactory control system of this kind is already in effect, it should devolve upon the industrial engineering staff to develop it.

It is not inappropriate for the industrial engineering staff to continue the function of the analysis of cost and performance records with a view to finding the items requiring attention. It is often possible, however, to convert this function into a more or less routine procedure that can be handled satisfactorily by someone in the maintenance department office.

All the activities we have mentioned with respect to preventive maintenance will ultimately lead to the development of standards. Although many standards may be completely arbitrary and yet incorporate all the advantages of standardization such as the adoption of one screw or nail size and shape instead of having several of almost identical proportions, most standards needed in a refinery are those which are developed from experience.

The constant aim of the maintenance organization should be to try to find a standard for everything. Every effort made in this direction will result in continuing improvement in every phase of the maintenance program.

Scheduling office.

Job Performance

In getting a maintenance job done correctly and economically, much more than technical "know-how" is needed. Again the activities of several groups may have to be co-ordinated. Careful planning must be done to the end that a large number of jobs can be carried on simultaneously and each job properly executed. The various steps to be taken and the problem that each involves will vary with the nature and size of the job but usually include the following:

1. Defining and describing the job
2. Engineering (design planning)
3. Manpower planning
4. Scheduling
5. Providing tools and facilities
6. Preparing the equipment
7. Selecting and assigning the men
8. Supervising
9. Following through

In the case of relatively small repetitive maintenance jobs, most of the above steps involve no problems; but all of the steps must have been taken at some time or the job cannot be done. In the case of larger jobs involving several crafts, many of the steps become real problems. If these problems are not thoroughly explored and a solution reached which is satisfactory to the persons responsible for carrying out the work, the job will not be done efficiently if it is done at all.

It is obvious in looking over these steps that the skills and responsibilities involved differ widely. In a very small plant one man may do all of them; but as the work increases in scope, specialization is found necessary. Too frequently the value of specialization is overlooked, or at least minimized. There is, in particular, a tremendous inertia in the thinking with respect to the functions and responsibilities of a supervisor. It is assumed that he, being a maintenance man, should know more about how to engineer, plan, and schedule a job than anyone else. Each of these are staff functions closely tied to the following step, but each requires an entirely different training in technique and procedure; and all differ from that required for the function of supervision.

To illustrate further, supervision, which is shown as a single function, is itself subject to specialization. When a maintenance job is being performed, there is needed a supervisor on the job to co-ordinate the various crafts and see that they perform their tasks. This is job supervision. At the same time, the members of each craft are subject to supervision by the craft leader who is responsible for their training in technique as

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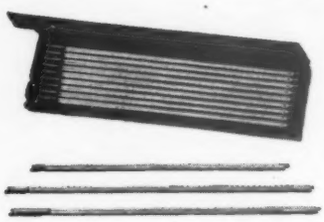

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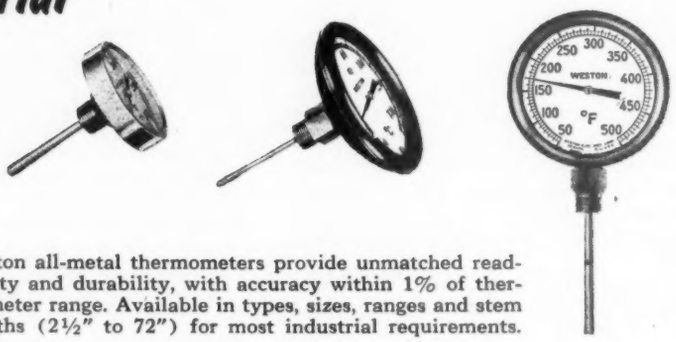

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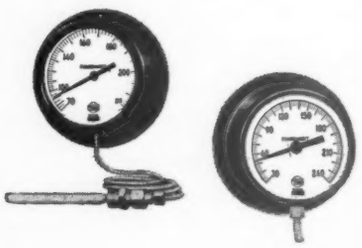

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craftsmen and in their duties and responsibilities as employees. He is responsible for the *how* part and the job supervisor for the *what* part of the plan.

A plan is but a guide. It takes management on the part of someone to make it work. Frequently great difficulties are encountered in trying to see that the plan is followed. This makes it appear that a plan may be good but supervision or execution faulty. This is not necessarily so; perhaps the planning simply did not go far enough. The difficulties involved in some of the steps were not foreseen. The variety of such problems and difficulties warrants detailed study and analysis, and here again is a typical field for the application of industrial engineering. Studies applied exclusively and continuously to the progress of the job will reveal the weaknesses in planning, and in most cases the logical solution will be apparent. The solution, the nature of which may be perfectly clear, may itself present serious difficulties. For example, if it is of an organizational nature, there may be involved obstacles in the way of major policy, tradition, training problems, etc. Technical problems are often much easier to solve.

If the people who are to do the work will face these problems and attack them willingly with a view to getting them solved by the best available means, that attitude in itself will have the major problem half-licked. There will be a constant search for things which are faulty or, if good, which might be made better. This applies to every factor in the nine steps which we have listed.

Such a program for searching out better ways of doing things goes further than the investigation of difficulties and obstacles referred to in following through the nine steps necessary for performance. The industrial engineering activities start with the ultimate objective of finding a better way to do every job. Planning and scheduling may be made to appear successful by various devices, one of which is overorganization. More men may be assigned to every function than are needed for that purpose. This may actually be desirable in getting the system started, and the studies will then take the following order:

(a) Determine how many men are actually being used for each element of the work and schedule accordingly.

(b) Eliminate from the schedule the excess manpower, making the men available for other work.

(c) Improve methods to reduce further the man-hour requirements.

The last stage of methods improvement is that in which the various standards which are needed begin to take form. In their final development, they are the results of the collaborated effort of the craftsmen, the operators, the supervisors, the industrial engineers, the designing engineers, and management. Experience in many industries shows that such standards can cover more than 85 per cent of the maintenance work. In any plant it is then and only then that we can hope to have the work proceed with the maximum smoothness and economy. * * *

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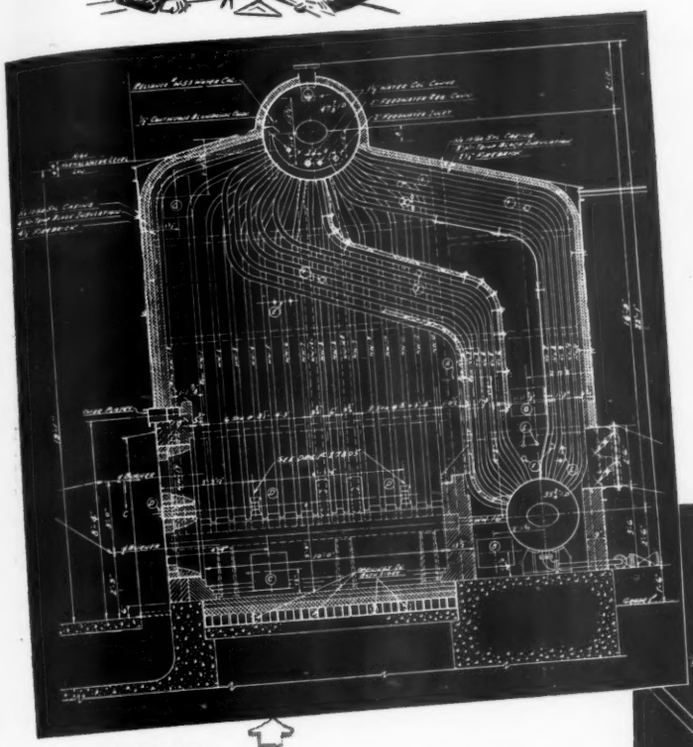

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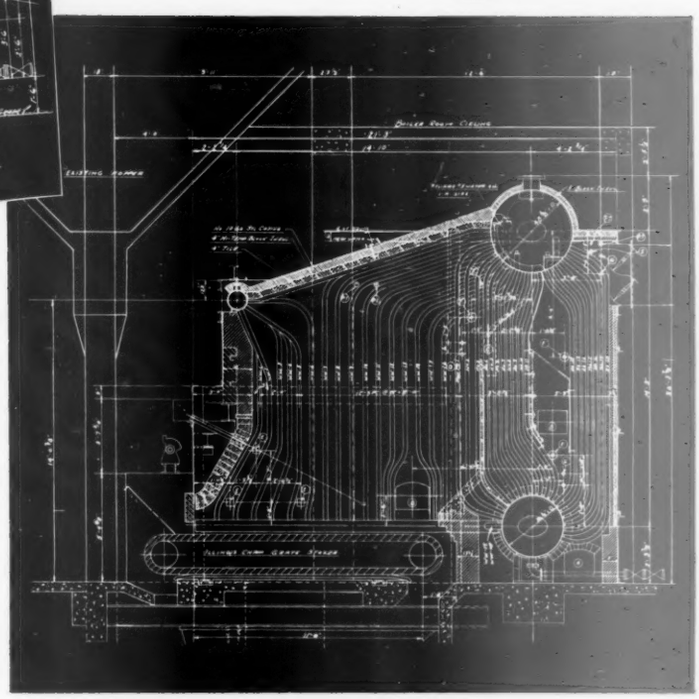

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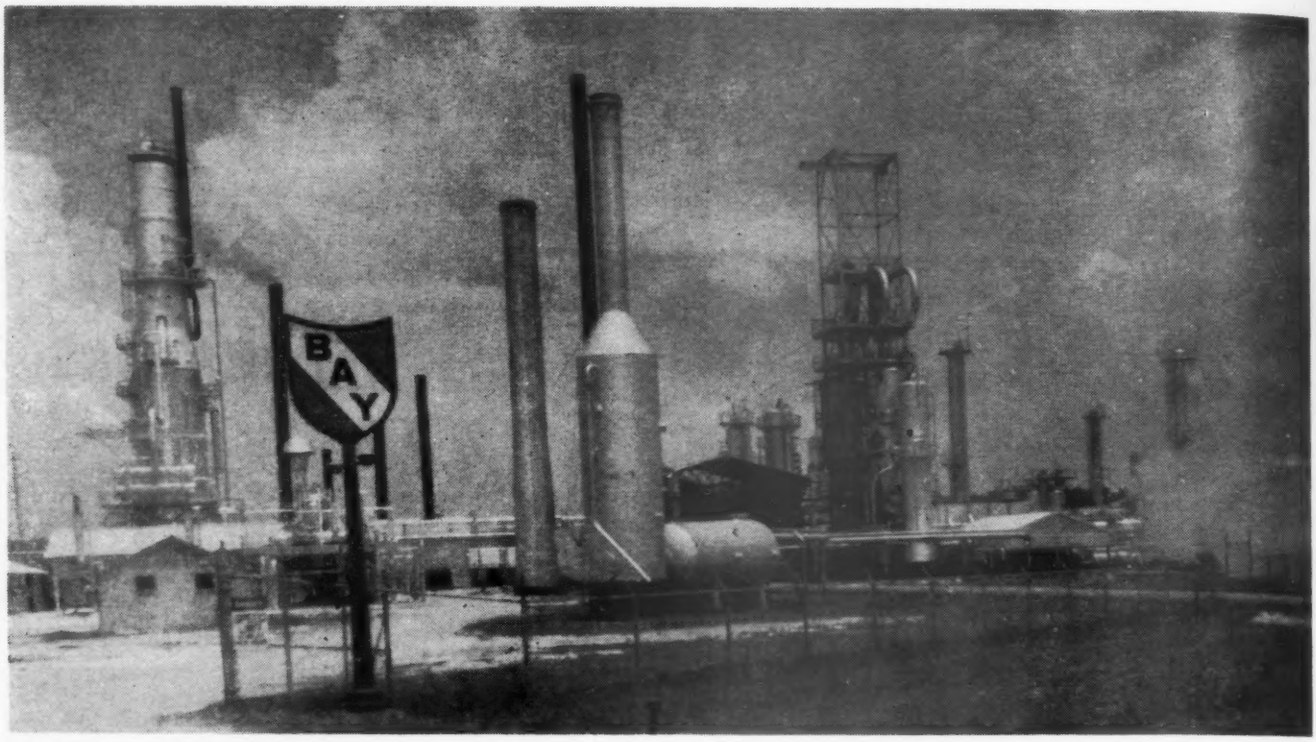


"Panorama" of rebuilt Bay Refinery at Chalmette, Louisiana.

Revised Plant Makes "New" One

Fluid catalytic cracker was added and flow changed in remainder of refinery to process more upgraded products

ARCH L. FOSTER*

ADDITION of a 7200 bbl per day fluid catalytic cracking unit, and revision of flow in the remainder of an existing plant have resulted in what amounts to a new refinery for Bay Petroleum Corporation, at its Chalmette, Louisiana, plant, just below New Orleans. This plant, formerly owned by Chalmette Petroleum Corporation and bought by Bay interests in 1944, found itself in the same position as that of practically every refinery in the country, following World War II.

This position is the problem of having too much residual-fuel oil producing capacity, and adequate quality production of motor fuel with thermal cracking gasoline. The difficulty was in having too little capacity for producing distillate fuel oils and for making motor fuels with high enough octane ratings to compete in current markets against refineries having the required capacities. When taken over by its present ownership the plant had a typical pre-war combination unit including topping, thermal gas oil cracking, and viscosity breaking. This system processed about 8000 bbl per day of mixed Louisiana crudes, the same crudes as are run now, to make competitive products before the advent of catalytic cracking into the refining picture.

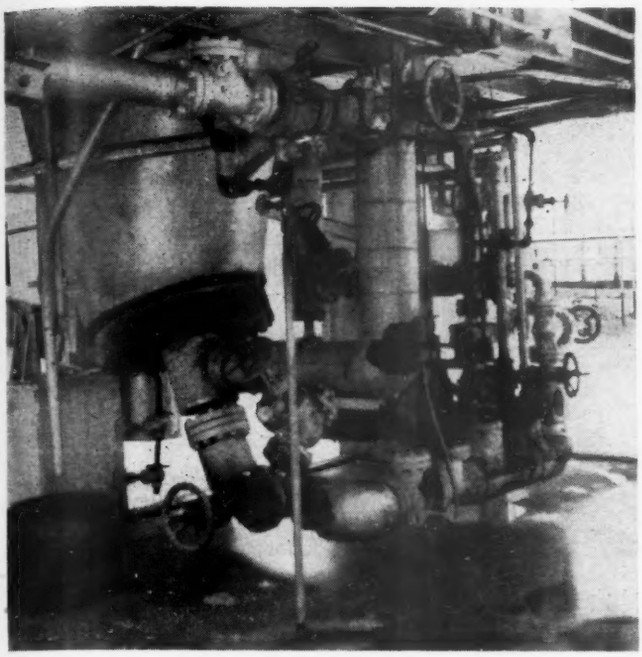
This situation being inadequate to meet the company's requirements the management in 1950 contracted for a Procon-built, Universal Oil Products Company designed, fluid catalytic cracking unit, that was planned originally to have a daily throughput capacity of 5640 bbl of gas oil, at a conversion of 76 per cent based on fresh feed. Also it was decided to revamp the combination unit flow and equipment to supply feed for the cat cracker with the result as is outlined below.

The engineers decided to rearrange the combination unit, formerly the crude and thermal cracking units, into a skimming and feed preparation unit. The former gas oil cracking furnace and the viscosity-breaking unit was retained in the same capacity as before. Crude is heated by exchange heat to a temperature of 375 F and most of the straight run gasoline is flashed off in a separate tower recently added to increase the crude throughput from a designed capacity of 12,000 bbl per day to 16,000 bbl per day. From the bottom of this flash tower, the preflashed crude is picked up by the former gas oil pump and discharged through the former gas oil furnace that was connected into the crude fractionator.

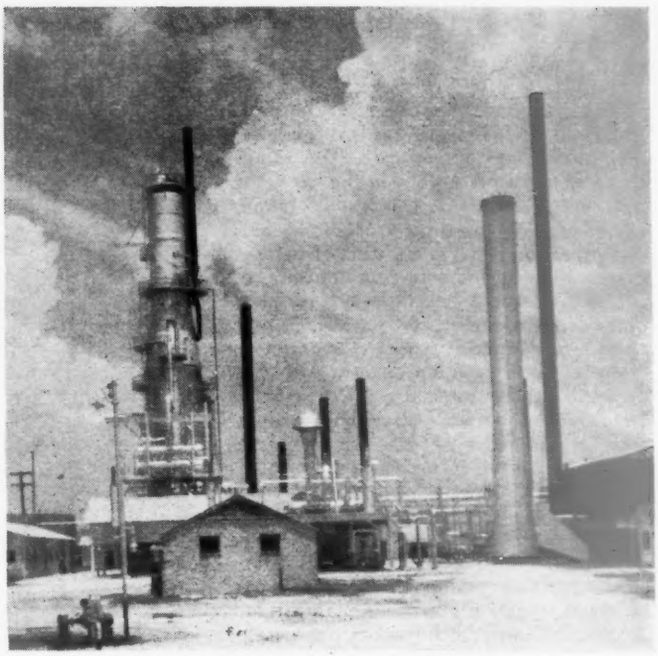
The crude oil heated to about 630 F is discharged into a second crude fractionating tower from which a stream of naphtha, kerosine, diesel oil, and gas oil are withdrawn. The bottoms from this second crude tower are pumped to the viscosity breaking furnace in which the topped crude is heated to about 890 F. This visbroken topped crude enters a flash chamber 9 ft-6 in. by 40 ft. From

*Editor, Refining and Gas Processing.

EXCLUSIVE



Manifold system at base of cracker.



New fluid cat cracker.

the top emerges a cut of gas oil and thermally cracked gasoline, which is separated into gasoline and gas oil in the former thermal fractionator column from which the thermally cracked gasoline is removed from the top and gas oil from the bottom. From the bottom of the flash chamber, the heavy fraction consisting of tar and heavy gas oil enters a vacuum column in which heavy gas oil is removed from the tar and added to the gas oil from the crude fractionator, the visbreaker fractionator, and sent to storage for cat cracker charging stock.

Formerly, the gas oil from the vacuum tower was the charging stock for the thermal cracker and the vacuum tower bottoms were regulated to comply with No. 6 fuel specifications, whereas on the present revamp job the vacuum column tar is blended with clarified slurry oil to comply with Bunker C fuel oil. Normally, the viscosity of this fluid is about 150 sec, Furol.

Average yields from the crude and vis-breaker system are as follows:

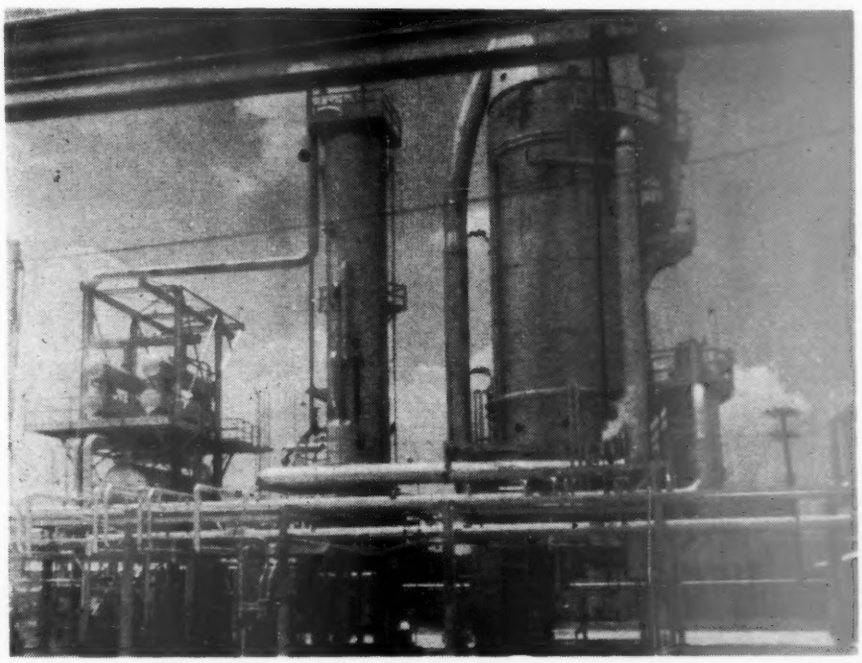
Straight-run gasoline	22 per cent of crude
Vis-breaker gasoline	1 per cent of crude
Kerosine	19 per cent of crude
Diesel fuel	7 per cent of crude
Gas oil (cat unit feed)	44 per cent of crude
Vacuum tower bottoms	6 per cent of crude
Loss	1 per cent of crude
Total	100 per cent of crude

The catalytic cracker now processes 7200 bbl per day of gas oil, is all built on deep piling, except the compressors. The old control room was retained, with a Panellit control board added. Raw oil, derived from the crude mixture, all of which are sweet is charged to the reactor riser line below the regenerator bottom and is joined by the slurry oil recycle stream and mixes with the hot regenerated catalyst from the regenerator bottom. The oil charge is not preheated but comes from storage at normally about 200 F. With the catalyst strips recoverable material from the added at 1060 F the oil-catalyst mixture passes into the reactor where, after reaction, the vapors pass overhead to the fractionator. Overhead the catalytically cracked gasoline passes to its condenser and receiver.

A side cut of No. 2 fuel oil—also called light cycle oil in plant operations—is steam-stripped to require flash point specification to meet market demands. Net slurry oil is drawn from the tower bottom and blended with heavy fuel oil as mentioned above. A waste heat boiler produces steam from a circulating slurry oil stream. The steam is added to the plant's other steam supply. This slurry oil also passes through reboilers on catalytic gasoline, poly unit depropanizer and debutanizer, and also the poly feed preheater.

Raw overhead gasoline goes to a condenser and receiver, thence to the vapor recovery primary absorber where it catalytic cracked gas. This "rich" oil goes to a receiver and is charged direct to the catalytic gasoline debutanizer where it is reduced to required vapor pressure specification. From the catalytic fractionator a portion of the unstripped light cycle oil is taken into the secondary or "sponge" absorber to contact vapors, and then is returned to the

Pumps, piping, and base of catalytic cracker.



catalytic fractionator from which it came.

Polymerization

The polymerization reactor contains five catalyst beds and maintains about 360 F average temperature. The minimum temperature rise from the exothermic polymerization reaction is taken across each bed and the stream is cooled to temperature by the addition of the required quantity of cool propane before entering the next bed. Fresh feed, and recycle drums are installed for mixing charge. The quench propane is pumped into the interbed open spaces, and the propane is separated by fractionation from the raw polymer stream, a portion of which is recycled. The unit charge enters in liquid form and is retained throughout the reactor. It contains some 57 per cent of unsaturates, propylene and butylenes. The raw polymer with one cubic centimeter of TEL shows a research octane rating of 99.3, and 3 cc boosts it to 100 research or higher. On the single "run" on the initial charge of catalyst to the poly unit since the plant was revamped the catalyst showed 120 gal yield of polymer per pound. It is expected that this figure will be increased materially in later runs.

From the polymerization unit, operating as formerly on all cracked vapors from the refinery, is obtained polymer approximating 10 per cent of the cracking unit charge. The debutanized catalytic gasoline is about 50 per cent of that unit's charge, making a total yield of catalytic and polymer gasoline of 60 per cent based on cat charge, to add to the 23 per cent of the crude taken as straight-run and vis-breaking gasoline. With the catalytic unit charging 44 per cent of the crude, the 60 per cent yield on charge becomes 26 per cent of the crude. This gives a total gasoline yield of about 49 per cent of crude charged. No. 2 fuel oil from the catalytic operation is about 26 per cent of the feed to this unit or No. 2 fuel oil yield is 11.44 per cent of the crude.

The slurry oil, blended with the heavy fuel oil (vacuum tower bottoms) is about 6 per cent of the catalytic charge; with the fuel oil equivalent (FOE) of the gas produced in the catalytic unit at 8 per cent, calculated, a loss of only one per cent is shown for over-all operations.

Yields, over a specific period of time and calculated carefully from summarized figures, show the following that may be taken as typical of the plant's routine operations:

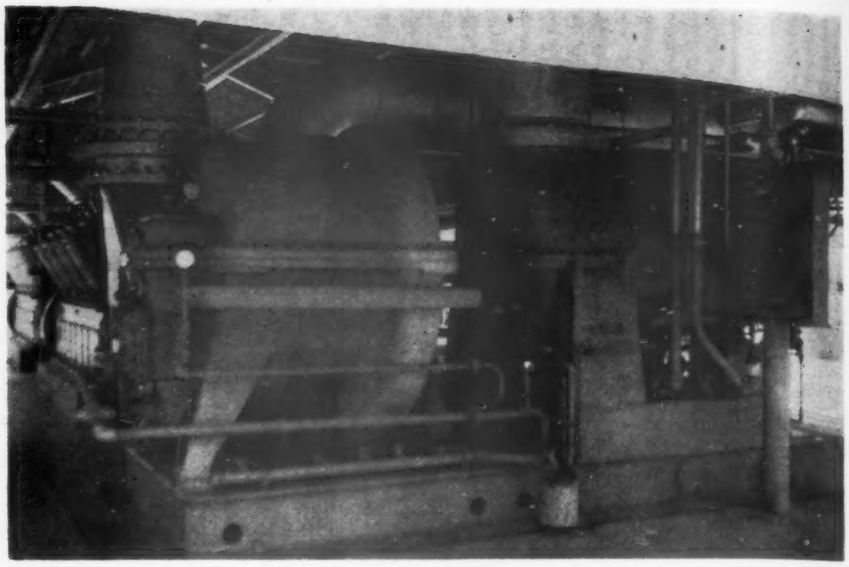
Product	Volume per cent of crude
Finished motor fuel	49.00
Kerosene	19.00
Diesel oil	9.00
Burner oil	10.00
Heavy fuel oil	8.00
Gas—FOE	4.00
Loss	1.00
	100.00

Future Plans

Plans are complete for installation of butane storage and for the distribution of butane as "bottled gas" in the territory. The polymerization unit is to be revamped to produce liquefied petroleum gas (LPG). An LPG truck loading rack is being constructed along the highway east of the refinery which will be semi-automatic in its operation. Butane will be distributed locally via tank truck for, largely, domestic consumption, as well as propane.

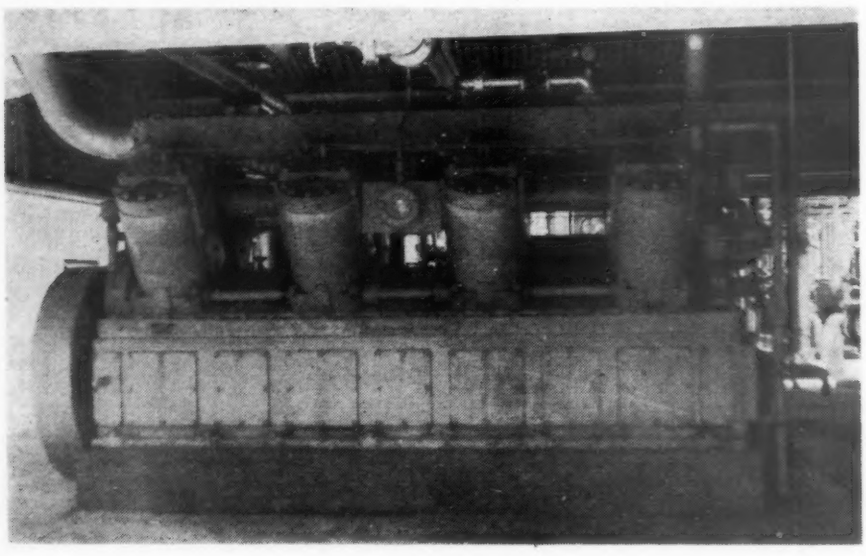
In revamping the polymerization unit, a gasoline stripper will be placed ahead of the debutanizer. This will strip non-condensibles including hydrogen sulfide from the poly feed stream, which will save on caustic required to neutralize the sulfide. Spent caustic used in removing hydrogen sulfide and mercaptans from the hydrogen streams is neutralized in a semi-continuous system, utilizing hot flue gas from the catalytic cracking unit. After complete removal of all sulfides and conversion to sodium bicarbonate the material is suitable for disposal in the waste water system. Poly feed thus will also be deethanized, which will permit the separation of relatively pure propane off the top of the depropanizer. Also, a propane dryer will be installed to take out water.

Cooling water for the refinery is obtained from the Mississippi River nearby, is mostly once-through. It is brought in by three electric-motor-driven pumps and, it has not been found necessary either to treat or filter this raw river water, except for boiler feed requirements. * * *



Moore steam turbine and carrier blower.

Ingersoll-Rand 8-cylinder compressors.



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Atomic Energy By-Products

Chemical engineering will profit from by-products of the Oak Ridge Atomic energy plant. Radioactive materials like carbon-14 can be used to measure flow rates in equipment operating under pressures as high as 150,000 psi. Apparatus developed at University of Illinois was described in a paper by H. G. Drickamer, K. D. Timmerhaus, and L. H. Tung of the University.

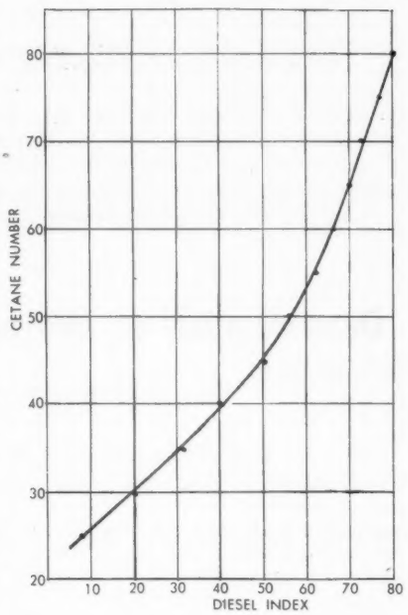
Cetane Number From Aniline Point

O. M. DUNCAN*

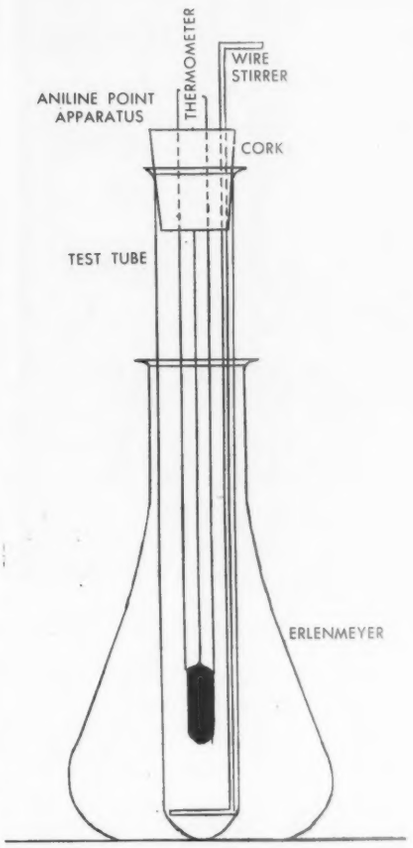
THIS method describes a simplified apparatus for the determination of aniline points and the calculation of diesel index and cetane number.

This apparatus has the advantage of being inexpensive and easy to use and the results obtainable are in close agreement with those obtained with more elaborate apparatus. The calculation of cetane number gives results for most stocks within two cetane numbers of those obtainable on the CFR engine whose reproducibility at the present time is not much better than this.

The apparatus consists of a test tube of about 20 mm inside diameter and 175 mm in length. The thermometer is mounted in a slotted cork so the bulb is in the center of the test tube and the middle of the liquid. A copper wire is bent to act as a stirrer. It can be moved up and down through the slot in the cork. The test tube is stood in a 250 ml erlenmeyer flask which not only supports the tube but acts as an insulator to help slow the rate of cooling.



Curve showing relationship between cetane number and diesel index.



Apparatus for determining aniline point.

Procedure

Into the clean test tube measure accurately 10 ml of pure aniline and 10 ml of dry sample. Filtering through several sheets of coarse filter paper will usually remove suspended moisture or CaC12 or anhydrous sodium sulfate may be mixed with the oil and then filtered out. The thermometer and stirrer are put in place and the test tube heated slowly over a small open flame until the mixture becomes clear while stirring. The test tube is now placed in the erlenmeyer and stirring continued at about one complete stroke per second until the mixture passes through the cloudy stage and becomes opaque. The temperature of the mixture at the instant it becomes opaque when held up to a window or similar light is the aniline point. The mixture should be reheated and cooled several times until 3 or more readings agree within 0.2 C. The average of these close readings is the aniline point in degrees centigrade.

Calculations

The aniline point as determined may be changed to degrees Fahrenheit as usual:

$$F = (9/5\ C.)$$

The diesel index may be calculated:

$$D.I. = \frac{G \times A}{100}$$

where

D.I. = the diesel index;
G = the °API of the sample, and
A = the aniline point in °F.

The cetane number may be taken from a curve obtained by plotting the following data:

D.I.	Cetane	D.I.	Cetane
8	25	62	55
20	30	66	60
31	35	70	65
40	40	73	70
50	45	77	75
56	50	80	80

A copy of this chart is shown herewith.

For samples lighter than gas oils, the following formula may be used to calculate the cetane number if the 50 per cent distillation temperature is known:

$$C = (D.I. \times D \times .0014) + 11$$

where:

C = cetane No.,
D.I. = diesel index, and
D = 50 per cent distillation temp.

Like octane number for spark ignition engines, the cetane number requirement of any given diesel engine cannot be specified accurately closer than several numbers so the above procedure is sufficiently accurate for perhaps 90 per cent of the routine testing of diesel fuels. Border line fuels of course should be tested in a cetane engine. It is also well to compare the results obtained by the above described method with those obtained on an engine for one or two samples from each type crude source to establish the closeness of the two methods.

*Indiana Farm Bureau Refinery.

Centipoise Viscosity of Crude Oils

THE viscosity of crude oil in centipoises is one of the factors used to evaluate the economics of secondary recovery. This viscosity at most any formation temperature may be calculated from the Saybolt viscosity and ASTM tables.

If the formation temperature is too high for an accurate Saybolt viscosity to be run at that temperature the

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TABLE 1. Viscosity of crude oil in centipoises.

STEP	EXPLANATION
1. From the °API @ 60 F find the hydrometer indication at the desired temperature. Example: Gravity @ 60 F = 34.8 API. Desired: Grav. @ 110 F find 34.4 on 110 F line. Hydrometer indication would then be 38.4.	1. Moving horizontally across the "API Gravity Temperature Correction Table" at the desired temperature find a figure in the body of the table that is within 0.5 of the gravity @ 60 F. Add or subtract the necessary tenths to or from the heading of the column to get the hydrometer indication @ the desired temperature.
2. From table of "Pounds per gallon and specific gravities corresponding to degrees API", find the sp.gr. of the oil corresponding to the hydrometer reading @ the desired temperature.	2. This is practically equal to the density of the oil in gm per ml at the desired temperature.
3. Determine the Kinematic viscosity in centistokes.	3. By converting from seconds S. U. Vis at the desired temperature using Table 1 in ASTM D-446 interpolating if necessary.
4. Multiply centistokes @ desired temperature by density at desired temperature.	4. To get viscosity in centipoises.

Saybolt Universal Viscosity may be run at two lower temperatures. These viscosities may be plotted on ASTM Standard Viscosity-Temperature Chart B (D341) and the extension of the straight line connecting the two may be used to determine the viscosity at the desired temperature.

The method of making the necessary calculations is shown in Table 1.

P. 221.5

Determination of Mercaptans in Finished Gasolines

MILTON R. BEYCHOK*

The most widely used method of determining the RSH (mercaptans) content of liquid hydrocarbons is the reacting of the RSH with silver nitrate and the back-titration of the excess silver nitrate with ammonium thiocyanate, employing an iron alum indicator.[1,2]

The iron alum end-point is the development of a reddish-brown color. When the RSH determination is being made on a pure compound, or an individual refinery stream, the end-point is fairly easily observed. When the determination is being made on a finished gasoline blend, however, one encounters two sources of interference: (1) the dye used in the gasoline is very often the same color as the iron alum end-point, and (2) the commonly used gum inhibitors manufactured by U.O.P., Du Pont, and Tennessee Eastman all develop a red color upon the addition of silver nitrate.

In order to remove the color interference of the dye, the author has found it extremely useful to remove the dye completely. This is easily accomplished by adding approximately one-half of decolorizing charcoal to 100 cc of the gasoline, shaking vigorously, and filtering through a Whatman No. 2 filter paper.

In order to remove the color interference of the oxidation inhibitors, they can be removed by scrubbing with a 1:1 nitric acid solution, decanting the gasoline, and filtering to remove traces of water and/or acid. Sometimes, the iron alum has been fortified with sufficient nitric acid to accomplish the same job. It has been found more satisfactory, however, to actually employ an acid scrub.

Both of the above steps can be accomplished in a matter of a few minutes, leaving a sample that has been de-colored and "de-inhibited." The usual RSH determination is then very easily and accurately determined.

*Chemical engineer, Long Beach, California.

[1]U.O.P. Method H-42—40, Universal Oil Products Test Methods.

[2]Method 520.4, Federal Specification, VV-L-791d, Amend. 1, June 20, 1950.

Readers Like Analytical, Test, and Inspection Section

The response of readers to the new Analytical, Test, and Inspection Section of Refining and Gas Processing, begun early in 1952 and continued throughout the year, has been most gratifying and we believe of distinct advantage to all concerned. A large number of procedures have been contributed.

If you have postponed writing up the new test method or procedure, or a variation or improvement or special form of a known procedure, we urge you to get busy, get it into shape, and forward to us without delay. This section can continue only if those interested cooperate by presenting their contributions as an exchange of knowledge with others in the industry. Photographs of apparatus are desirable but not indispensable. Drawings are most desirable, to illustrate for the reader the means by which a method, process, or procedure is carried out. Drawings may be in pencil, if clear and exact so that they may be reproduced in ink with certainty. Dimensions are also very desirable. Again we urge you to write up your procedure and submit to us without delay. (We'll even PAY you for it!).—Editor.

CLARKSON PLANT EXPANDING

Due to its remarkably strategic site on the shore of Lake Ontario, between Toronto, capital of the province, and Hamilton, the "Pittsburgh of Canada," and in close proximity to other key manufacturing and agricultural centers the British-American refinery at Clarkson promises now to become one of the most valuable of B-A properties across the Dominion. It is about to undergo an $8,000,000 expansion program.

With dock accommodation, including approach, 1900 ft in length and 32 ft in width, four lake tankers to maximum draft of 24 ft can be berthed simultaneously. When the new Lakehead pipe line extension from the interprovincial terminus at Superior, Wisconsin, to Sarnia delivers crude from Alberta directly to the latter point, the Clarkson plant is expected to reach the peak of its yield of refined products.

The unit at present comprehends topping and cracking, propane deasphalting, furfural, dewaxing, and clay contact items, asphalt and blending plants, dorr separator, re-run unit, acid treater, foamite building, white products building, rundown tankage, crude tanks, administration offices, laboratory, boiler-house, stores, and machine shops. Steam supply needed to operate pumps, turbines and compressors and to provide heat for oil tanks and buildings is generated by four Foster-Wheeler steam generators, with productive capacity of 252,000 lb of steam per hour.

Heat exchangers total 160 and the aggregate heat transfer surface is 85,000 sq ft.

Processing comprises this set-up:

Daily capacity of crude oil (24 hr) — 15,000 bbl.

Production of lube oil — 40,000 gal.

Number of pressure vessels — 210.

Maximum oil temperature — 1100 F.

Temperature recorded at — 350 stations.

Maximum pressure — 1800 psi.

Height of tallest tower — 112 ft.

Heat released in oil furnaces — 210,000,000 Btu per hour.

The 230-ft power-plant stack, with average dimension of 14 ft, is composed of 530 cu yd of concrete. Boilers' capacity is 7.2 hp. Capacity of the air compressors is 1000 cu ft per minute.

Of the total tankage capacity, 104,389,000 Imperial gallons, the largest tanks are each 115,000. The 310 pumps have a total daily capacity of 60,000,000 Imperial gallons, with 12,500 valves in operation. There are 58 miles of piping and 60,000 ft of copper tubing.

The land acreage of the plant is 327 and the total concrete yardage 35,000. Flanges number 13,000 in all.

Prior to 1951, the crude oil processed by the Clarkson refinery was obtained from the Mid-Continent and Illinois oil fields. Now, however, Canadian crude reaches the plant by tanker delivery from the Interprovincial flow at Superior.

The daily consumption of electric power is sufficient to light the homes of a city of 200,000 population, is supplied at 26,400 v and reduced in the refinery's own transformers to 550 v for motors and 110 v for illumination.

Water is pumped directly from Lake Ontario at a normal rate of 8000 gal per minute, is utilized to cool and condense products and to generate steam. In the event of fire, water at the rate of 3750 gal per minute at 160 psi from electrically pressure-driven pumps at the water pump-house. The water intake pipe is 42 in. in diameter and extends 1500 ft out into the lake.

—*Harry Chapin Plummer.*

Aurora to Install Second Platforming Unit

Aurora Gasoline Company, Detroit, Michigan, will install a second UOP Platforming unit, this one to be built at its Elsie, Michigan, refinery. Aurora has been operating a Platformer at its Detroit refinery since 1951.

The unit at Elsie, like the one at Detroit, will be designed to produce high octane motor fuel. Product from the unit will be marketed in the Michigan area. The Elsie Platformer will have a design charge capacity of 1500 bbl per stream day compared with 4500 at Detroit.

The contract for the construction of the unit at Elsie has been awarded to Procon Inc., Des Plaines, Illinois.

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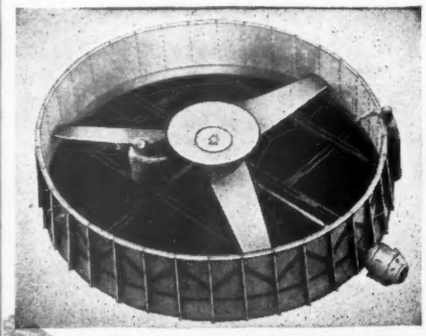

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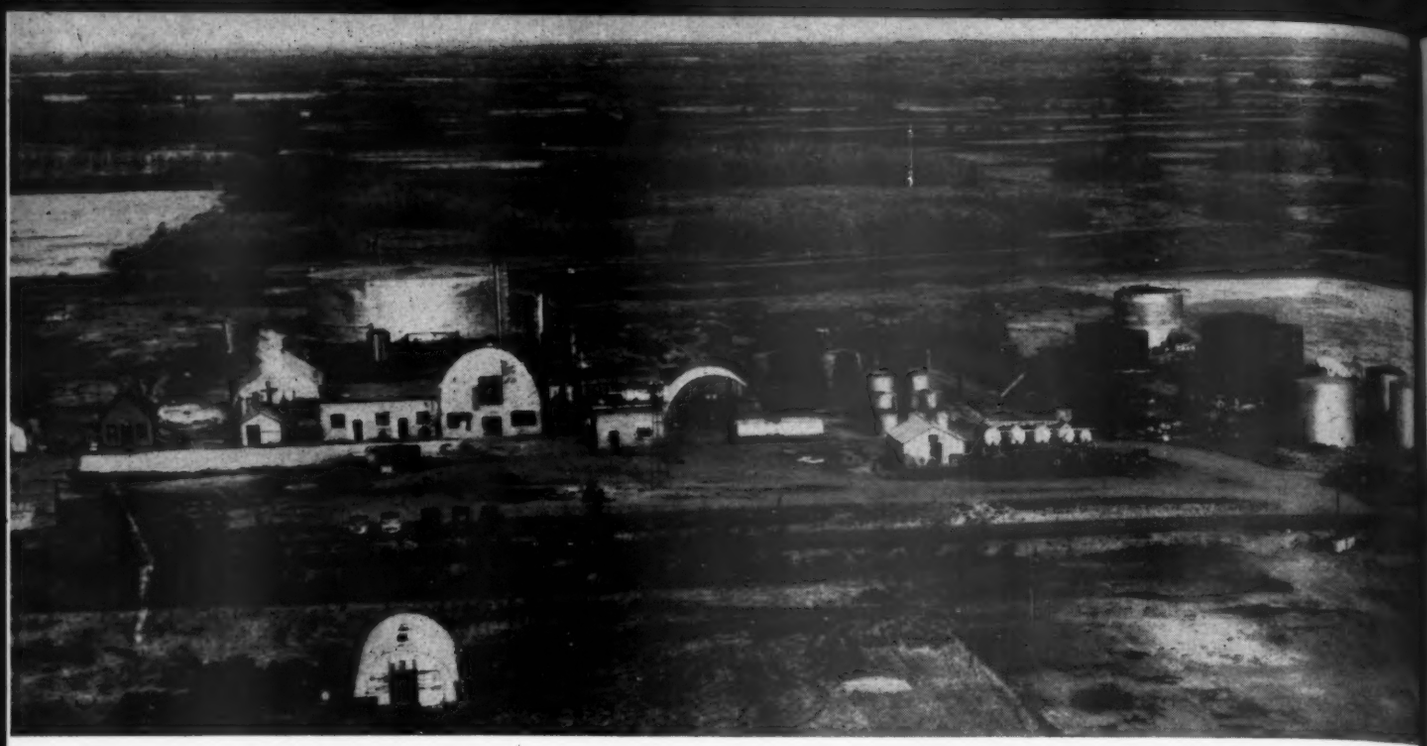


Aerial view of Excelsior refinery at Lloydminster, Alberta, Canada.

P 713.

Oil Products From Heavy Canadian Crudes

Wilrich Petroleum's increasing market for heavy crudes in Canada has given the company sizable interests throughout oil area of that country

GEORGE A. RICHARDSON

WILRICH PETROLEUMS LIMITED is a Canadian company, engaged in the exploration and development of oil and natural gas over a wide variety of fields, as well as having a large interest in closely related companies in drilling, servicing, and refining.

The company holds varying interests in some 831,670 acres where 80 producing gas and oil wells, and indirect interests in other wells, account for a net reserve of 11,398,340 bbl of oil. This program extends through the Alberta fields of Leduc, Whitemud, Excelsior, Redwater, Holden, Coronation, McLennan, Medicine Hat, Pouce Coupe, and Lloydminster; the British Columbia area of Lone Mountain and Flathead; the Saskatchewan fields of Maidstone; the Manitoba areas of Birdtail and Russell, and the Poplar Dome field of the Williston basin in northeastern Montana. Rounding out the company's diversified interests, Wilrich controls and operates Red Willow Drilling Company Ltd.; has large interests in Oil Producers Ltd., a drilling and servicing organization, and a sizable interest in Excelsior refineries.

Although Wilrich has a solid foundation in its light oil producers in the Leduc, Excelsior, and Whitemud areas of Alberta and its heavy oil producers in the Lloydminster and Maidstone areas, the more exciting exploration operations are concentrated presently in three spots.

In the Poplar Dome field in the Montana portion of the Williston basin drilling is being carried on at the Wilrich-MacDonald No. 1 site, offsetting the anticipated producer, Ajax McGowan No. 1, where drillstem tests have indicated commercial production.

In the Lone Mountain area of northern British Columbia, wet gas seepages have posed a challenge to companies for years and here Wilrich is carrying a heavy interest in a drilling operation about which the company's geologists are optimistic. At its present level, approximately 3000 ft, geologists have been able to correlate the sediments found at the 8000-ft level in a recent Phillips-Lone Mountain drilling. The fact that the Wilrich-Trans-Era well is drilling approximately 5000 ft higher than the Phillips well would indicate

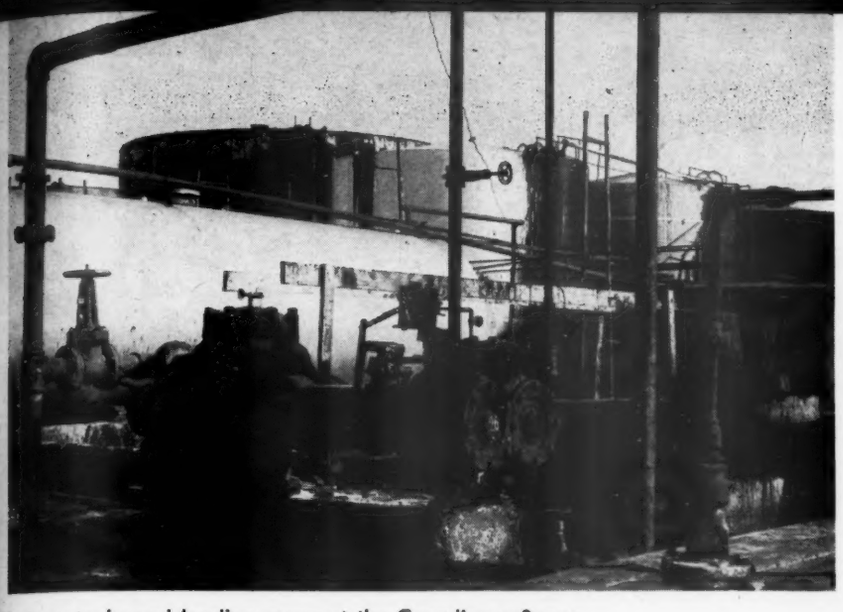
EXCLUSIVE

The Author

George A. Richardson, president, Wilrich Petroleums Ltd., has long been

associated with the development of the petroleum industry in Canada. He was an "original" in the Athabasca tar sands. In 1939 he drilled the discovery well at Spring Coulee, southwest of Lethbridge, Alberta, and the following year, his well was the second in the Vermilion field. He discovered the Blackfoot field in 1944.

The Peace River country of B. C., and in particular the Monkman Pass region, holds a great deal of interest to Richardson. In 1935 he led a pick and shovel brigade of farmers over the Monkman Pass from Beaverlodge, Alberta, to Hansard, B. C., to prove a road was possible out of the Peace River country to link up with the coastal and interior highway systems of the province. It is in this area where his company is drilling a wildcat.



Storage tanks and loading pump at the Canadian refinery.

that at the projected depth of some 6000 ft, the lower marine bullhead sands, familiar to those found in the productive Fort St. John field will be traversed.

In the Maidstone area of Saskatchewan, Wilrich holds a 33 1/3 net interest in 78,000 acres capable of supporting many wells. A well-projected program has been formulated with the idea of not only replenishing depleted reserves in fields already producing but with the idea of developing additional production of heavy crude to supply the Excelsior refineries in the Lloydminster area, a refinery in which Wilrich Petroleums itself has a sizable interest. The fact that Wilrich has such large proved reserves in this area makes it a vital factor in any refinery production program and gives it a natural association with the Excelsior Refineries, Ltd., at Lloydminster.

Excelsior, with a daily capacity of approximately 2500 bbl is under the management of L. R. Cox, a Tulsa University graduate with a degree in engineering from the University of Kansas. His U. S. experience with Globe Oil and Refining Company of Wichita, Kansas, and later as superintendent of National Co-operative Refining at McPherson, Kansas, makes him a particularly valuable asset to Excelsior in its program of processing the heavy black crudes, characteristic of the Lloydminster and Maidstone fields.

Being cognizant of the increasing market for asphalt materials for road, laminated building boards, asphalt planking, roofing, pipe covering, and bunker fuel for railroads and diesels—Excelsior has developed into one of the principal Western Canadian suppliers. Excelsior's plant expansion is planned to meet their increasing demand.

The plant is designed to process a crude high in asphalt content and infused with salt, water, and some sand. Cleaning and de-salting are the first phase in the process, which produces mainly by volume, a straightrun material primarily for road surfacing. The lesser portion of output is blown material brought up to specifications set for roofing and pipe covering.

Impurities in the Lloydminster crude, highly suited to production of asphalt, consist of water, salt, and other minerals in varying amounts ranging up to 3000 lb per 1000 bbl of crude. This is reduced by the initial de-watering and desalting to a range of 15-20 lb per 1000 bbl of crude.

Where the crude is heavy enough to equal the specific gravity of the salt water admixture the impurities remain emulsified and are not automatically separated out by gravity. Cause of the emulsification is obscure, but it is thought to occur as the oil and water exude together from the interstices of the productive sand. Main emulsifying agents may be hydrous silicates of alumina involved in a colloidal action, or may be finely divided solids.

Crude, purchased on the basis of gravity and B. S. & W., is delivered to the refinery by tank truck from the surrounding Lloydminster field of Alberta and Saskatchewan. Trucks empty the crude in underground tanks where initial settling takes place. A further decrease in B. S. & W. occurs with the reduction of viscosity as crude passes to the heating sections and is raised to 80 F by live steam coils.

The crude is first charged to heat exchangers that receive heat from exhaust steam. The temperature rises to about 130 F before the stock is passed to the Petreco dehydrating unit. Oil leaving the top of this vessel enters a surgedrum, from which it is pumped, along with fresh water and chemical, through heat exchanges that further increase the temperatures before the stock reaches the desalter. Salts, sand, and excess water are drawn from the bottom of the dehydrating-desalting units to disposal traps.

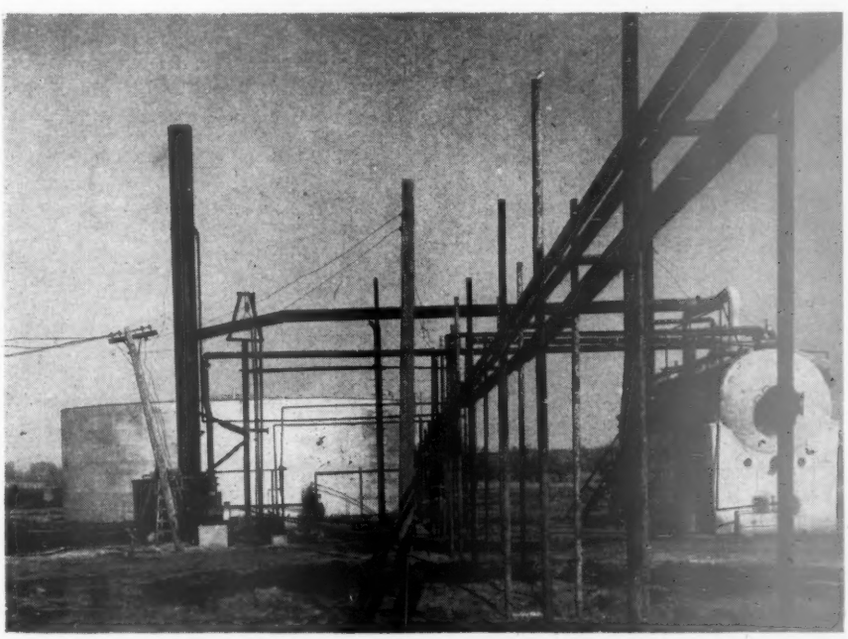
The removal of water-extractable salts is regarded as of first importance in order to minimize corrosion and the plugging of equipment, as well as to reduce impurities in the products. Two of the four operating units in the Excelsior plant act as dehydrating units, with the remaining two acting as desalters. After cleaning the crude flows from the top of the desalting tank to storage.

Cleaned crude from storage is charged through heat exchangers receiving heat from the fractionating tower bottom product before entering the furnace. From the furnace, the crude passes into the flash tower, along with live superheated steam.

From the top of the flash tower the oil passes into the fractionating tower. Side streams and an overhead stream of gasoline are taken from the fractionating tower. Side streams are stripped in separate strippers with steam and the make normally goes to a run-down tank.

Vapors from all strippers are returned to the tower immediately above the draw-off plate for that fraction; provision is made for returning reflux to to the tower immediately below the draw-off plate in each case. Topped

Asphalt still and storage tanks. Note railway tank cars at left.



The town of Lloydminster, Alberta, from the air.

crude that accumulates in the base of the flash tower then is pumped either to an asphalt stripping tower or to the oxidizing still.

Blown and straight run—the latter being the most important from the point of view of volume—are the two types of asphalt produced at the refinery. The straight-run is used primarily for road surfacing. It is produced by distilling off the lighter fractions to yield a residue of pre-determined penetration, containing the heavier compounds present in the charge. The properties that are important to asphalts intended for use in roofing materials and pipe coverings, as well as other industrial purposes, include weather resistance, a high softening point, low flow at high atmospheric temperatures and yet they must not become brittle at low temperatures.

Such a material is made by passing air through a given volume of the residium obtained from the flash tower bottom. Moderately high temperatures, ranging from 400-600 F are maintained during the blowing period which, depending upon the properties desired in the final product, covers from 8 to 24 hours. External cooling is required after the initial phase, as the reaction is exothermic.

Several types of end products require the use of a catalyst during the blowing period.

Variation of characteristics of different types of asphalt is shown in the following table:

Specific gravity at 77 F..	1.00–1.17	0.90–1.07	0.90–1.10
Penetration at 77 deg...	10.5	11–18	20–25
Fusing point (R & B method, F).....	0	190	190
Flash point, F.....	400–600	350–500	350–550
Fire point, F.....	450–650	400–650	400–650
Solubility in carbon disulfide %.....	85–100	95–100	95–100
Color.....	Variable	Bright to dull	Bright to dull
Ductility 71 deg.....	Variabl	3.8	7.9

Regarding fuel oil, the tank combustion in terms of British thermal units per pound of oil is higher with the lighter fuels but is lower in British thermal units per gallon with lighter oils, the heavier oils thus being cheaper for fuel at the same price per gallon, which is the normal unit measurement. In addition to the use of this fuel by the railroad market, a part of the fuel requirements of the refinery are met through this medium, in that steam generating boilers are equipped with fuel oil burners.

Light end fractions from the Excelsior plant are finding an increasing market. One of these is the diesel fuel market, where extremes in cold weather cause trouble with ordinary fuel. The Excelsior diesel fuel is characterized by its ability to flow at extremely low temperatures as illustrated.

Test	Specification	Excelsior fuel
Appearance.....	clear	clear
Flash point, F.....	Min 110	160
Viscosity, CSTKS at 100 F....	Min 1.6, Max 4.28	3.49
Sulfur %.....	Max 1.0	1.95
Cloud point F.....	Max —30	Below —60
Pour point F.....	Max —40	Below —70
Water & sediment %.....	Max 0.05	Nil
Acidity.....	Nil	Nil
Corrosion.....	Pass	Pass
Distillation range, F 90% point	Max 600	600
End point.....	Max 0.15	0.04
Aniline point F.....	....	131.7
Diesel index number.....	Min 40	40.6

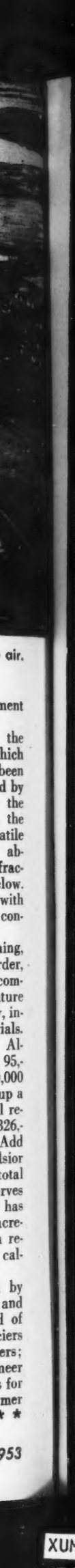
The low cold test feature, is of course, an asset to the burner fuels as well as the diesel fuel fraction. At the present time, all of the gasoline fraction of the crude is marketed as tractor fuel since the volume by per cent of crude is small.

Recent addition of a vacuum unit has enabled a slight change in the plant's operation. Temperatures were adjusted to compensate for the added equipment and capacity.

Topped crude is the charge to the vacuum unit, that is crude from which the lightest fractions have already been removed. The topped crude is heated by pumping through coil or tubes in the furnace. After being injected into the vacuum tower where the more volatile fractions flash off because of the absence of pressure, and the heavier fractions are separated in the trays below. The vacuum tower is maintained with the steam ejectors and barometric condensers.

With its currents interests in refining, drilling, and producing well in order, Wilrich, like an well-organized company, has planned its future. The future of the oil industry must, of necessity, include a healthy reserve of raw materials. Wilrich, with its 151,318 acres in Alberta, 544,752 in British Columbia, 95,600 acres in Saskatchewan and 40,000 acres in Manitoba, is able to prove up a net interest of 80,050 bbl of light oil reserves and a total net interest of 1,826,033 bbl reserves of heavy crude oil. Add to the latter a large interest in Excelsior Refineries fields, and you have a total net interest of 11,826,033 bbl reserves of heavy black oil in which Wilrich has interests. Beyond this are the large acreages in the Maidstone are in which reserves have not yet been accurately calculated.

The management group, headed by H. W. MacAdams, general manager and secretary, is supported by a board of directors made up of Canadian financiers T. R. Harrison and Gordon K. Masters; Colin A. Campbell, consulting engineer and former minister of public works for the province of Ontario, and a former Member of Parliament. ★ ★ ★



Powell Engineers always look to the future

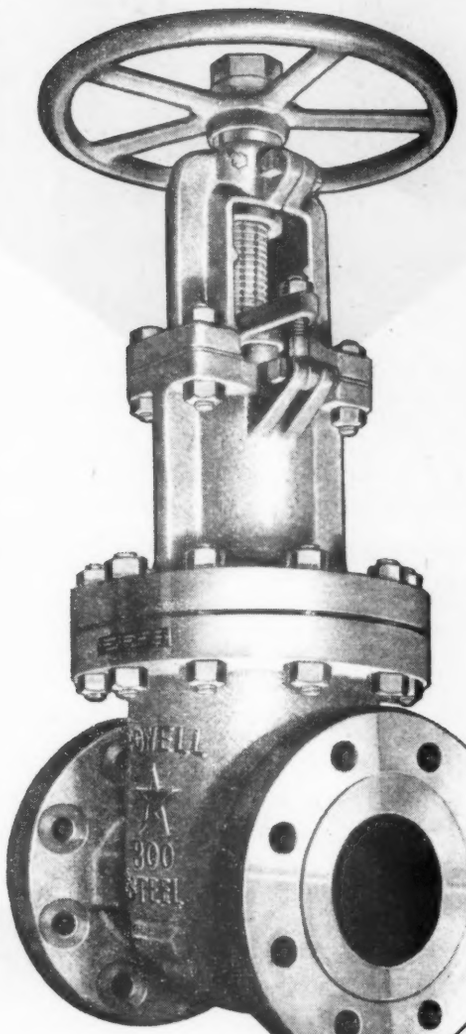


Fig. 3003 — Series 300-pound, Cast Steel, O. S. & Y. Gate Valve with flanged ends.

Powell Valves are not only made in every type, size and material needed to meet all your flow control requirements but, because Powell Engineers always look to the future, they give special attention to those important details in design that make all Powell Valves give such long, dependable service and require so little maintenance.

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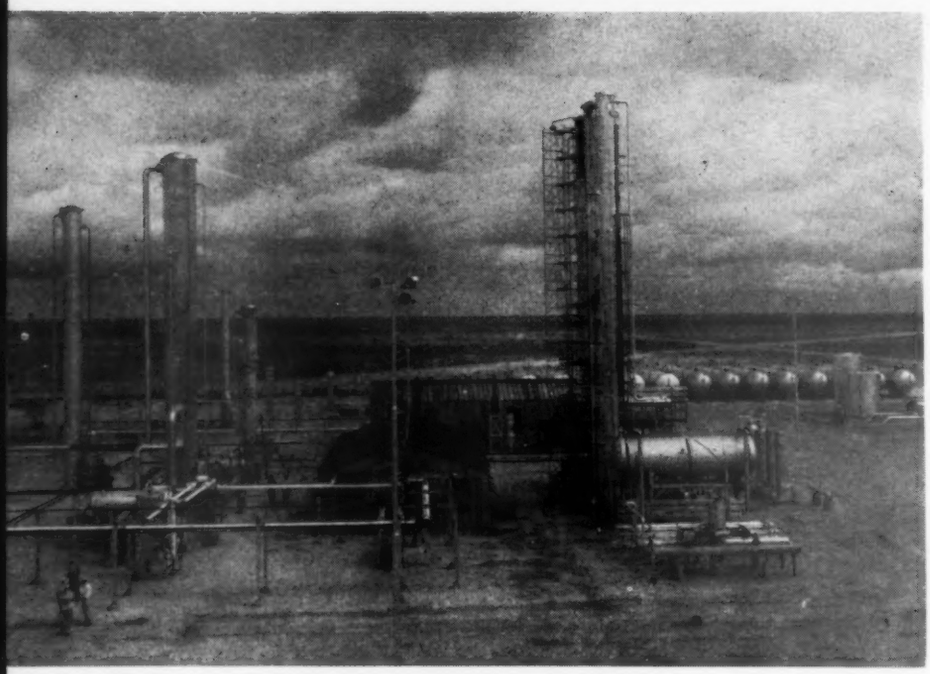


Shown above: High pressure absorber, rich oil stripping still, amine stripping still (background), reabsorber, process pump building, compressor building (behind pump building), fractionating towers (debutanizer, depropanizer, deethanizer) raw charge tank (horizontal), and products storage tanks in background.

Transfer Gasoline Plant to West Texas in Record Time

ARCH L. FOSTER*

IN the interest of saving gas and recovering otherwise wasted light hydrocarbons it was necessary for Lone Star Producing Company and its cooperating partner the Wilshire Oil Company, Inc., in the Ellenburger-Wilshire field, Upton County, Texas, to install a natural gasoline and gas treating plant there at once. Industrial conditions being what they are, it would require a full year or more to build a new plant. That was too long a time. So the company with fine collaboration from all concerned, merely moved an existing plant, hooked it up and started the compressors and the pumps. And all this in between January, 1952, when the move was begun, and the middle of July, when the plant began operations in its new home.

Wells were coming in at a great rate in this field, and the Texas No-Flare law for gas is working well-nigh perfectly. So this plant was transferred and installed in record time, for a throughput capacity of 6,000,000 cu ft of gas per day, as of the present. The plant was transferred from Leeray, near Moran, Texas, to its present site. Plans are to double this capacity by the installation of additional compressor capacity. At the time of starting the plant Wilshire has 11 producing wells; Sinclair about 14 wells, and Standard Oil of Texas 8 producers. The present total number of wells in the field is 33.

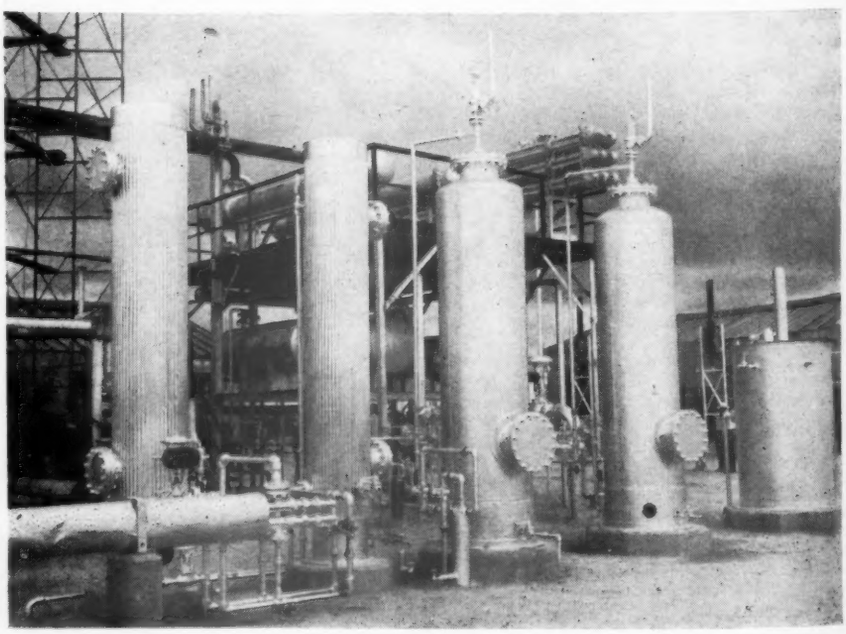
The plant is a conventional oil absorption unit; two gas streams are brought in at different pressures. The high pressure stream comes in at about 600 to 800 psig, and constitutes only a small portion of the plant's throughput. The remainder is low pressure gas, coming in at about 25 psig through a different line and different meters, and is picked up by three 300 hp Clark MA-8 compressors bringing up the pressure to that at which the plant is being operated, that is, the high pressure gas stream at the time. The plant operates normally at a pressure consistent with the pressure of the El Paso Natural Gas Company's line, to which the stripped, desulfurized (H_2S) and dehydrated gas is delivered for transmission to consumer centers.

Both streams of gas, after boosting the low pressure stream up to operating pressure, enter the Amine type desulfurizing unit where it is brought into countercurrent contact with a 10 per cent monoethanolamine solution at about 90 F, to remove hydrogen sulfide, after which the sweetened gas goes directly to the absorber. The hydrogen sulfide gas released from the amine solution by regeneration with heat and steam is burned in a flare with barely enough gas to maintain the flame.

Desulfurized gas passes from the

*Refining Editor.

Propane dryers, Perco gasoline treaters, condensate accumulator.



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WHEN YOU SPECIFY

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Here is the gauge that provides absolute protection to the viewer from tube rupture due to any cause.

In this new Ashcroft Maxisafe* Duragauge, an integrally cast solid wall separates the dial from the Bourdon tube and movement. The entire back of the case is covered by a double spring-mounted safety release plate. Teflon coated and tightly fitted on a rubber gasket, the plate is held in place by a knurled knob. If the tube ruptures, pressure less than ½ p.s.i. will force the plate open and vent the discharge to the rear.

Always be on the safe side. Get absolute protection against the possibility of tube rupture — specify the Ashcroft *Maxisafe* Duragauge. The *Maxisafe* has all the long-life durability and precision accuracy of standard Ashcroft Duragauges. It's available in all Duragauge pressure ranges, Bourdon tube materials, case designs except type Number 1179, and mountings, in 4½, 6 and 8½ inch dial sizes. Ask for details in selecting *Maxisafe* Duragauges. Phone your local Ashcroft Gauge Distributor.

*Reg.

NOTE THE SOLID WALL

that separates the dial from the Bourdon Tube and movement. Three ¾" lugs on the back flange hold the *Maxisafe* away from the wall and permit the safety plate to release. *The case design also provides easy, quick access to the movement and tube assembly for inspection, repair or recalibration.*

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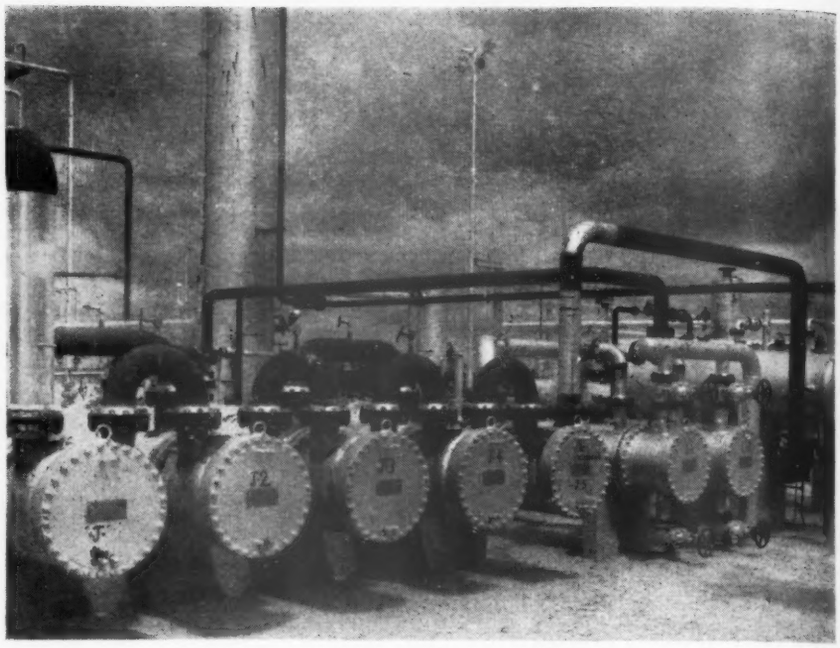
amine treating unit directly to the absorber at about 90 F, with no intercooling. It it met in this column by absorption oil of about 200 molecular weight, which picks up propane and heavier and the residue gas goes to two dehydrator columns containing Florite, which reduces the water content to some 9 lb of water per million cubic feet. This residue is delivered to El Paso Natural Gas Company lines at the existing line pressure of 600 to 800 psig.

Rich oil from the bottom of the absorber is stripped at about 125 psig; in a single still.

The reabsorber is operated at about 100 psig. Vapors flashed from the rich oil vent tank join those from the raw charge to the fractionator system, and others from the deethanizer accumulator to return to the reabsorber to remove any recoverable hydrocarbons. Lean oil streams going to both the absorber and reabsorber are chilled by propane refrigeration to about 70 F to improve absorption.

The fractionator system includes the deethanizer column as "first stop" for the raw "make" from the still, which operates at about 400 psig. Deethanizer bottoms go to the depropanizer column operating at 250 psig. Overhead from this column shows 95-98 per cent propane, which after cooling is stored as LPG. The propane-stripped bottoms from this tower are introduced to the debutanizer operated at 120 psig. From the debutanizer top is taken a stream containing about 75 per cent butanes, which also is disposed of as LPG. The debutanizer bottoms product is a natural gasoline.

As a matter of course the product and the amount of production varies with overall conditions. Average yield from the gas as received is approximately 3 gal per 1000 cu ft, total liquid. A caustic wash system has been installed to treat the fractionator charge to insure that the products are sweet. The various products are also run through a Perco treater to remove essentially all of the corrosive elements.



Rich oil-lean oil heat exchangers and lean oil coolers.

High pressure centrifugal pumps handle the absorption oil streams, driven by steam turbines. The absorber receives about 200 gal of oil per minute, while the reabsorber has a circulation of about 100 gal per minute. An oil reclaiming system by passing a part of the absorption oil continuously through a clean-up or reclaimer system, will be installed. Oil-to-oil heat exchange is employed before the rich oil reaches the vent tank and still. Steam is used as heating medium for the various reboilers in the plant.

Boiler capacity includes five 125 hp oil field type boilers, gas fired. Cooling and condensation is obtained by water in a closed system from the cooling tower, to the exchangers and/or condensers, and back to the tower again, for recooling of the water stream. The cooling tower, aided by the very low humidity of the atmosphere, and induced draft fans will give a water temperature of 80 F as a rule.

Two 125 kw, three-phase, gas engine-driven alternators develop all the power required for the entire plant. No outside source of electric power is tied in with this plant which must be self-sustaining in this respect. Water for the plant's boilers and coolers is obtained from seven wells, 21 miles from the plant. Consequently air-cooling, as indicated by the accompanying photos, is utilized in several applications for cooling purposes, to take as much load as possible off the water system. Practically all the water that is immediately local is "gyp" (calcium sulfate) water, nearly useless for plant purposes.

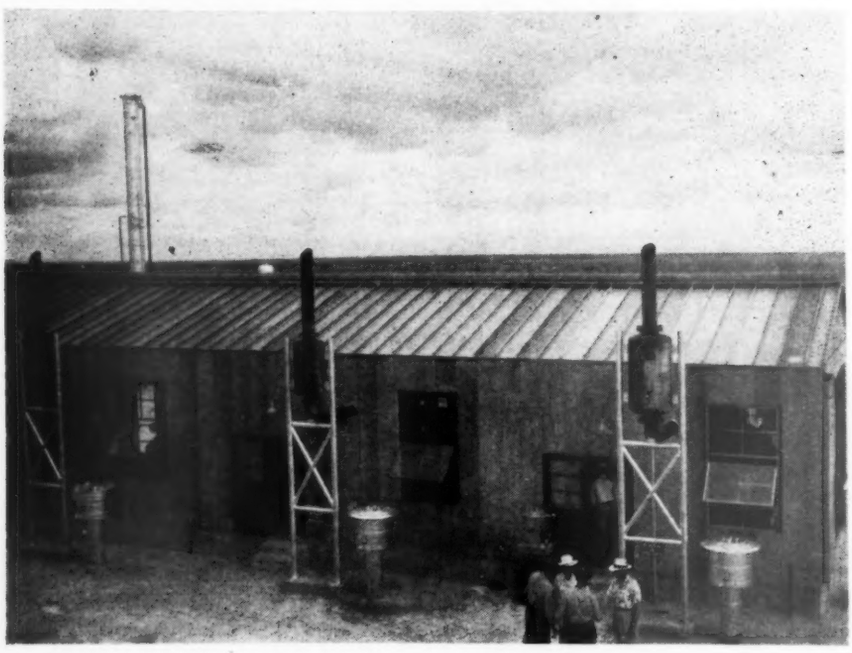
Among the innovations introduced into this plant is that of the use of stripped and desulfurized gas as instrument "air," that is, to actuate and power the instrument system of the plant, the gas in this system being used at about 60 psig.

Also, no direct fired heaters are used in the plant, steam and/or heat exchange being employed exclusively in reboilers, preheaters, amine solution regenerators, and other equipment.

To improve the working conditions for the administrative and operating staff a duct cooling system is installed in the office building, employing an evaporative type water cooler.

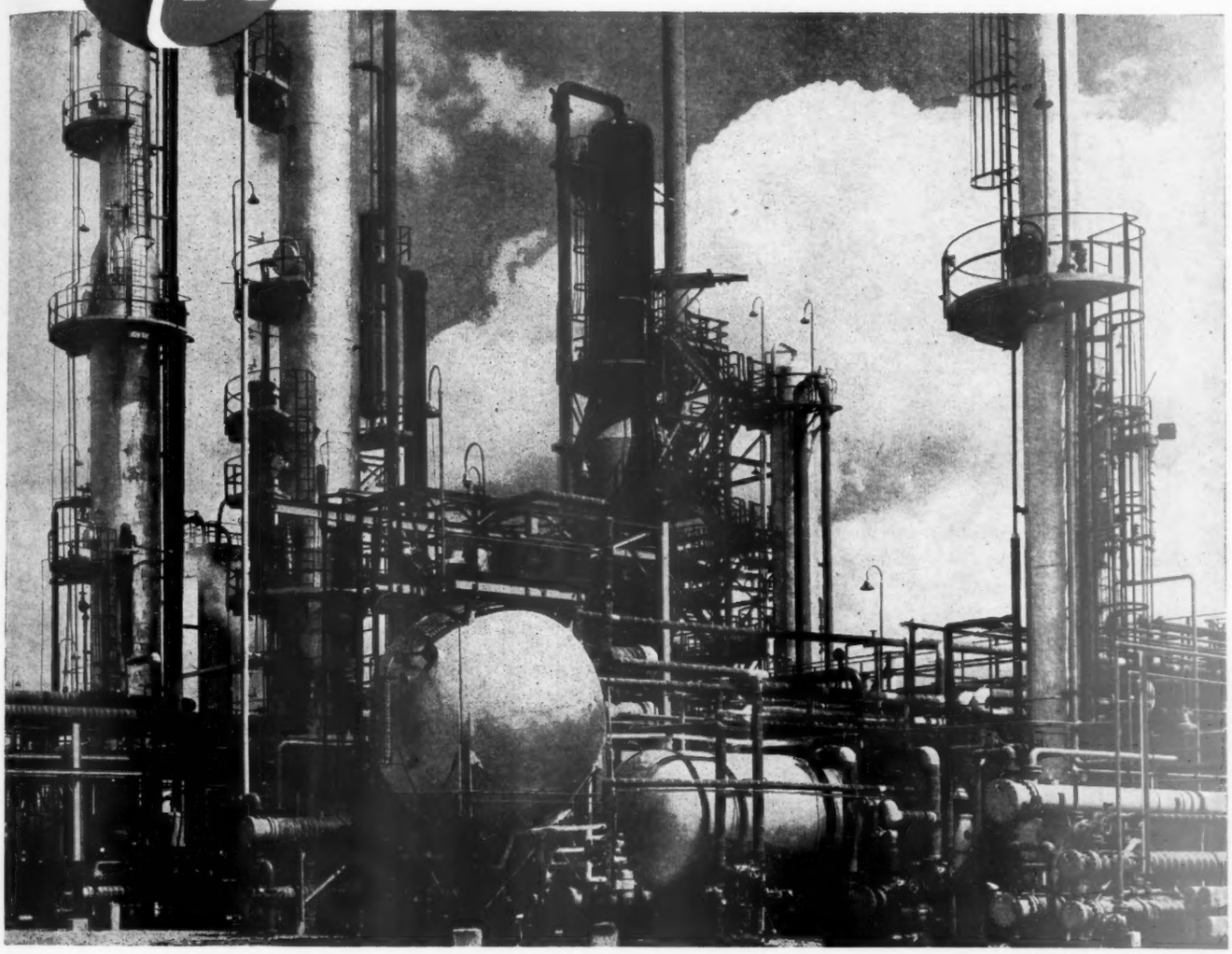
Many of the different operations are outlined in the accompanying photos and the explanatory captions therewith, more detailed discussion of which will not be included here. * * *

Gas compressor building.



THE BRITISH AMERICAN OIL COMPANY LIMITED

another leading refiner who desalts with PETRECO



At Edmonton, Alberta, The British American Oil Company Limited has recently put into service a complete new refinery. Intended to handle production from Canada's great western oil fields, this new British American installation incorporates the most modern developments in refining technology. Like other leading refiners everywhere, British American at Edmonton relies on Petreco for desalting.

The Petreco desalter illustrated above desalts 5200 barrels per day of Redwater crude, with salt removals ranging from 94% to 96%. The electrosphere is one of Petreco's new high-efficiency, high-throughput spheres, eleven feet in diameter.

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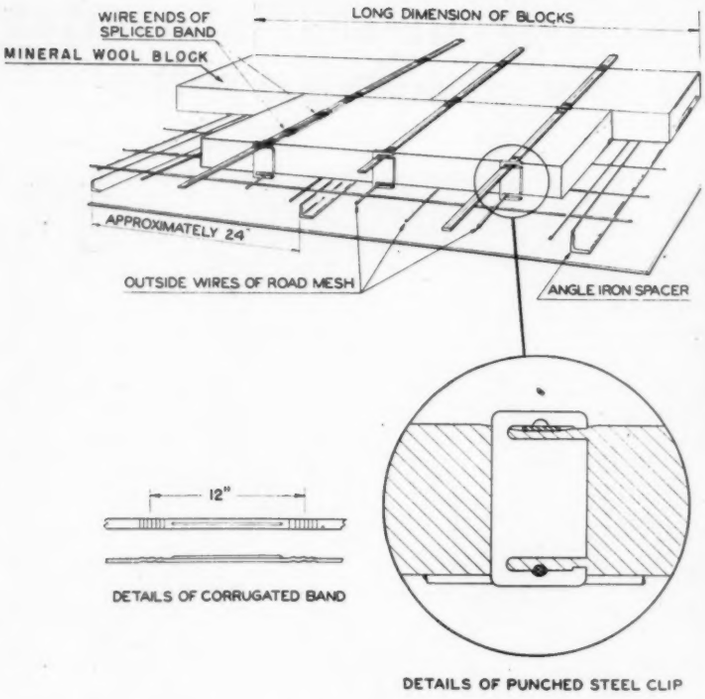


FIG. 1. Details of (1) application of mineral wool blocks over 6-in. by 6-in. road mesh, (2) corrugated steel band, and (3) punched steel clip.

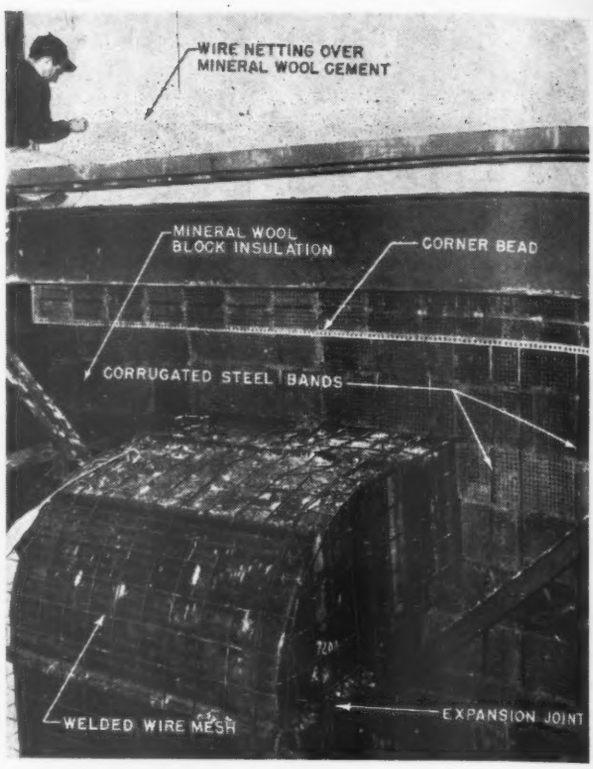


FIG. 2. Three stages of spaced duct insulation. Wire mesh on by-pass duct (lower left). Banded blocks on lower part of forced-draft duct. Mineral wool cement and wire netting over insulation blocks on upper part of f-d duct.

Mineral Wool Blocks Spaced on Ducts for Efficient, Dependable Service

SPACED application of duct insulation is being adopted by many engineers and plant designers as one of the most versatile, dependable, and efficient methods for insulating high-temperature gas and air ducts in both central generating stations and industrial power plants. Good appearance and a tight heat barrier are provided in the smooth, unbroken insulation surface that encloses ribs, flanges and stiffeners projecting from the ducts. Because the insulation is not applied directly to the duct surface, less special expansion joint treatment is necessary to prevent the occurrence of expansion cracks.

The four basic materials used in the spaced method of duct installation are (1) 6 by 6-in. road mesh, (2) mineral wool block insulation, usually in 12 by 36-in. sections, (3) corrugated steel bands, and (4) special punched steel clips. The 6 by 6-in. road (wire) mesh is the foundation material and the corrugated bands and punched steel clips are the securing members. The major application details and materials are given in the drawing in Fig. 1. The photograph (Fig. 2) shows an actual installation in three stages of application —wire mesh on a by-pass duct (lower left), insulation blocks and bands on the lower part of a forced-draft duct, and mineral wool cement and wire netting as part of the finish on the upper part of the 600 F duct.

*Industrial Mineral Wool Institute, 441 Lexington Avenue, New York City.

Installation

The 6 by 6-in. road mesh is stretched over existing ribs, flanges, and stiffeners and tack-welded at approximately 24-in. centers over the duct. If there are insufficient ribs or stiffeners to allow tack-welding of the wire road mesh to projecting members at 2-ft intervals, it is recommended that additional angle-iron spacers (Fig. 1) or studs be welded to the ducts. Splices in the wire mesh should be made by lapping so that the wire runs in straight unbroken lines in both directions. In order that the securing members be uniform, the outside wires of the road mesh should all run in the same direction on a given surface. The outside wires are usually installed vertically on vertical or inclined surfaces and are placed parallel with the longest dimensions of horizontal surfaces. The wire mesh is cut to fit around pipes, hatch openings and protruding connections. The wire mesh is bent down and welded to the duct surface at the edges of openings such as access doors.

In addition to providing the extra benefit of good appearance, the flat, unbroken surface of the road-mesh foundation permits the installation of large-sized insulating blocks with minimum cutting and shaping. As a result, considerable installation time is saved and there are fewer gaps at edges and corners of the insulation.

Application

After the wire-mesh foundation has been installed, the gaps around flush openings are filled with miter-cut sections of mineral wool blocks wired to the bent road mesh. The thickness of

EXCLUSIVE

the block insulation to be applied over the road mesh depends on the surface temperature of the duct. Commercial Standard CS117-49, "Mineral Wool Insulation for Heated Industrial Equipment," recommends minimum insulation thicknesses from 1-in. at temperatures less than 200 F to 3-in. for duct temperatures as high as 700 F. Above 700 F, where more than 3-in. of insulation usually is used, mineral wool blocks may be applied in two layers. Because most air and gas ducts operate at temperatures less than 700 F, the block insulation is usually applied in a single layer.

The mineral wool block sections are applied in parallel rows, starting from the bottom on vertical and inclined duct surfaces. The block insulation is secured to the road mesh by ¾-in.-wide corrugated steel bands which are held in place by specially designed punched steel clips (Fig. 1.) The steel bands are installed at 12-in. intervals parallel to and directly over every other row of outside wires. The punched clips are snapped over the outside wires and the steel bands between each row of block insulation.

For the specified thickness of insulation, the size of the steel clip is selected so that it will slightly pinch the insulation when snapped in place. Because the corrugated bands have sufficient stiffness, each mineral wool block in subsequent rows of insulation is placed against the top edge of the previous row between the road mesh and the extension of the band. On vertical and inclined surfaces, therefore, it is not necessary to provide temporary attachment before another clip is snapped in place on the other edge of the insulation to secure the block permanently. Each block of insulation is individually attached to the wire-mesh foundation.

Plasterer's corner bead is installed on edges and outside corners of the ducts. The corner bead is held by tie wires attached to corrugated bands spaced no more than 6-in. from the corner. Corner bead helps to insure tightness of the insulation joint at the corner, protects the insulation from damage, and improves appearance.

Mineral wool cement and finishing cement are applied over the block insulation to level off the surface. Whether indoors or outdoors, the duct insulation may then be finished with asphalt weatherproof mastic (dry thickness, ⅛-in.) trowelled over 1-in. galvanized wire netting which has been stretched tightly over the cement surface and wired in place with 16-gage soft iron wire. As an alternative finish for indoor locations, six or eight-ounce canvas may be sewed or pasted evenly in place over the mineral wool cement. When pasted, it is important that all wrinkles be smoothed out of the canvas before drying. The stitches on sewn canvas should be spaced no more than ⅓-in. apart and, for the sake of good appearance, seams should be located where least conspicuous. Ducts located indoors may be finished with two coats of paint applied over the finishing cement. * * *

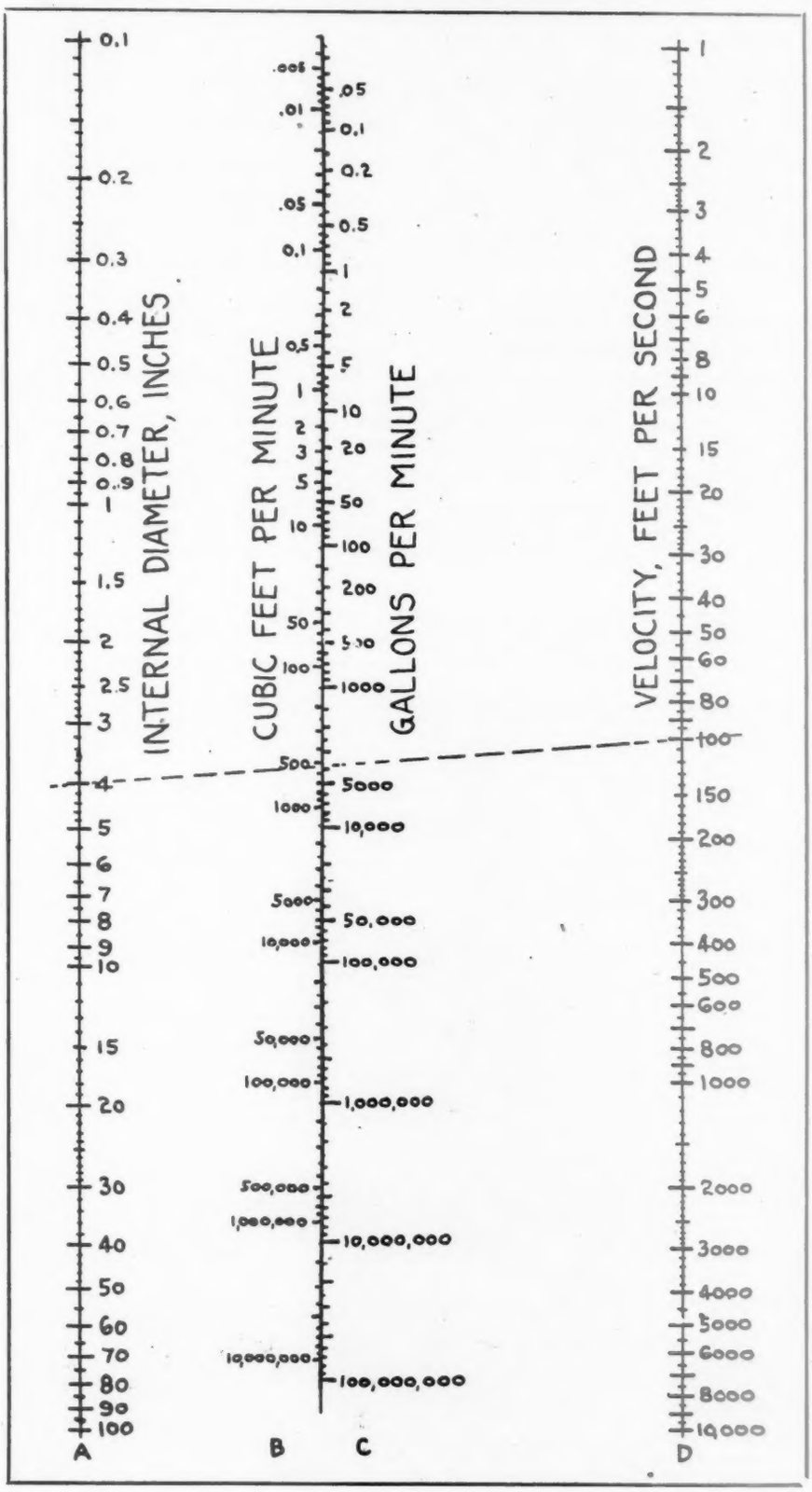
PLANT AID

Petroleum Plant Chart

How many cubit feet?
How many gallons?
What velocity?

Any one of the above questions is instantly answered for the petroleum plant operator by simply laying a straightedge across this chart.

For example, how many cubic feet of liquid or gas will flow per minute through a 4-in. pipe at 100 ft per second? The dotted line drawn across the chart shows how it is done. Connect the 4 in Column A with the 100 in Column D and locate the intersection with the middle column. Column B then tells us the answer—very close to 525 cu ft per minute. At the same time Column C tells us that the equivalent volume is 3900 gal per minute.—W.F.S.



News

Illinois Institute Sets Up Catalysis Research Program

Personnel and facilities especially fitted for catalysis research have been coordinated by Armour Research Foundation of Illinois Institute of Technology. The move is designed to meet industry's growing needs for such a service, according to William A. Casler, assistant director of research. Heading up the program is Dr. Charles H. Reisz, well known in the petroleum and utility gas industries. Prof. Vasili I. Komarewsky, director of the catalysis laboratory at Illinois Institute of Technology, is consultant to the group. Coordination of the work is conducted through the Foundation's physical chemistry section under the supervision of Dr. John E. Barkley. Dr. Julian Glasser, research engineer in the Foundation's materials and processes division, was active in establishing the new program and serves as a member of the catalysis research group.

Chemical Bank Sets Up Oil and Gas Department

Chemical Bank and Trust Company has established an oil and gas department to specialize in all phases of banking for the petroleum and natural gas industry, it was announced by N. Baxter Jackson, chairman.

Philip F. Shannon has been appointed senior consultant and Ben F. Zwick has been appointed manager of the department, which will become part of the bank's national division. It will be under the supervision of Howard W. McCall, Jr., vice president, with headquarters at 165 Broadway, New York.

Chemical Courses Listed

A directory of chemical engineering faculties in the nation's colleges giving courses in chemical engineering is announced by the American Institute of Chemical Engineers. The listing, which is available from the organization at 120 East 41st Street, New York 17, New York, is the work of their chemical engineering education project committee under the supervision of Kenneth A. Kobe, professor of chemical engineering at the University of Texas.

Safety Awards Given

In the course of an impressive ceremony at the Clarkson refinery recently company checks representing each one day's full pay were presented, as "safety awards," to 600 employees. For at that time the staff of the refinery had completed 1,000,000 man-hours without a lost-time injury.

This is the second time in three years, and the fifth time since the refinery was put "on stream," in 1943 that the plant employees have qualified for the president's award in recognition of their contribution to B-A's safety program. Company officers, civic, safety, and compensation board officials were in attendance at the latest presentation.

Monsanto Plant Produces Vinyl Chloride Monomer

Monsanto Chemical Company's Texas division plant here has begun production and regular shipments of vinyl chloride monomer. The vinyl chloride monomer is being made from acetylene, hydrochloric acid, ethylene, and chlorine. Ethylene dichloride is produced as an intermediate in the vinyl chloride process. Productive capacity of the Texas City plant will be large enough to allow marketing of ethylene dichloride as well as the new monomer, R. U. Haslanger, sales manager for Monsanto, reported.

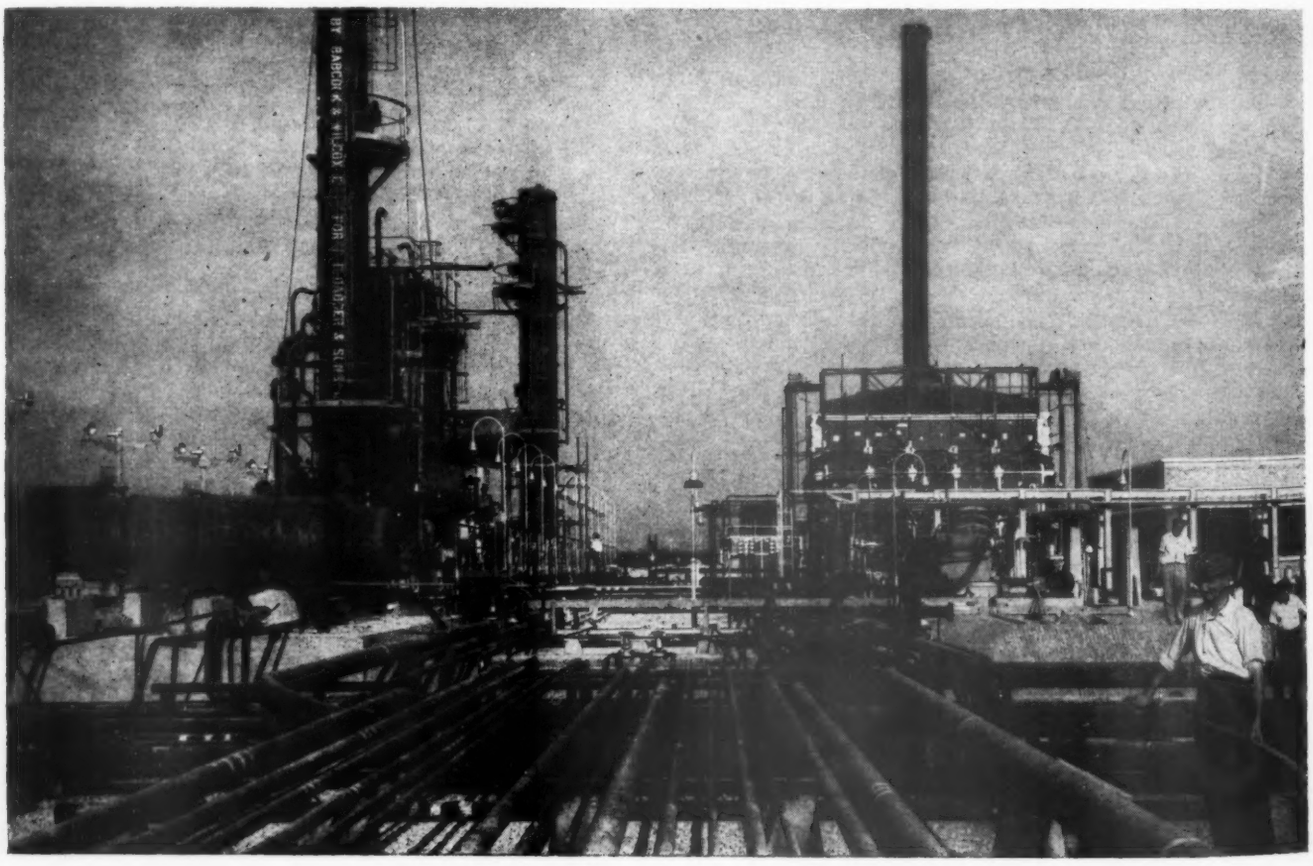
Italian Refinery Is Put Into Operation

Operations have begun at the newly constructed Italian refinery at San Martino di Trecate, between Milan and Turin, the industrial heart of Italy. This was announced by the American partner in this undertaking, the Caltex Oil Products Company.

This major inland refinery is owned by "SARPOM" (Societe Azioni Raffinerie Padana Olii Minerali), and the Italian partner with Caltex in this organization is the great Fiat Company.

Initial operations on Middle East crude are progressing satisfactorily and are already providing high grade petroleum products for distribution in Italy. Formal opening ceremonies for the new refinery are planned for early 1953.

At Trecate in Northern Italy, a new refinery has just been completed by Sarpom in the Po River Valley about 20 miles west of Milan. The Sarpom refinery is a joint venture undertaken by Caltex and Fiat to supply refined petroleum products to Italy's expanding industry and economy and is designed for daily crude oil charge of 13,300 bbl.



Metal Congress Meets

Development of metals for use in the petroleum field and refinery will be stressed by speakers and exhibits at the Western Metal Congress and Exposition, announcements. Technical sessions will be held in the new Statler hotel, and the exhibits will be shown in Pan-Pacific auditorium and a large adjacent pavilion.

W. H. Eisenman, secretary, American Society for Metals—engineering society of the metals industry, stated particular attention will be paid to high temperature metals notable for their resistance to corrosion, acids, and chemicals.

Three Bar Plant Operating

Construction work is proceeding on the processing area of the new Three Bar gasoline plant, near Andrews, Texas, which will be operated by Stanolind Oil and Gas Company for a group of owners. The plant will have a design capacity of 20,000,000 cu ft of gas per day, with an initial compressor installation to handle 11,100,000 cu ft per day. Operating at design capacity, the plant will recover 90,000 to 140,000 gal of natural gasoline, butane, and propane each 24 hours. Glenn A. Ayling of Stanolind is plant superintendent.

New Unit to Be Installed At Japanese Refinery

Daikyo Oil Company, Ltd., of Tokyo will install a Houdriflow catalytic cracking unit at its Yokkaichi, Japan refinery, it was announced by Houdry Process Corporation and their foreign representatives, World Commerce Corporation S. A., New York.

The new Houdriflow, the first to be installed in the Orient, is designed for a gross capacity of 4200 bbl per day.

Engineering for the Yokkaichi Houdriflow will be provided by Houdry Process Corporation, and construction will be handled by a Japanese engineering firm.

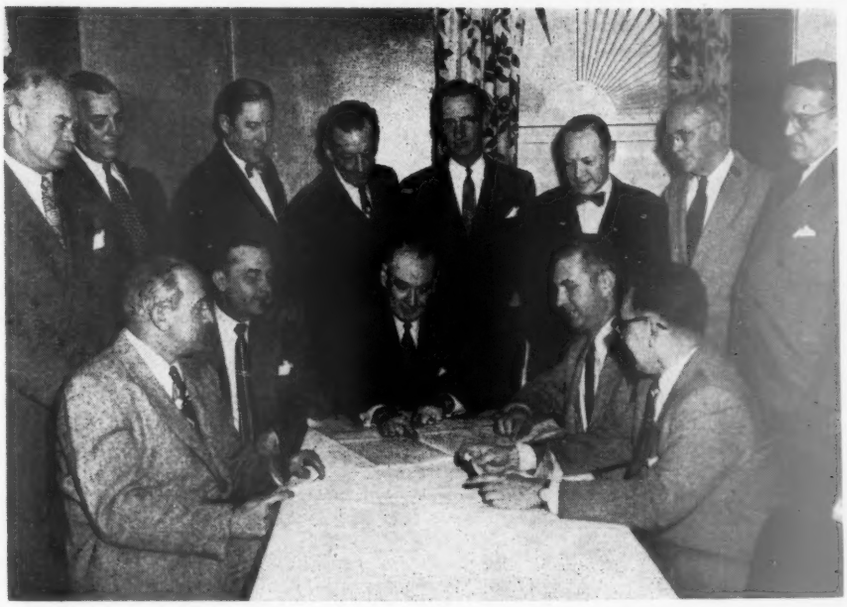
Shell Oil to Enlarge Ventura Gasoline Plant

Shell Oil Company has awarded Fluor Corporation, Ltd., a contract involving approximately $1,000,000 for extensions and revisions to the company's Ventura, California, natural gasoline plant, according to an announcement by S. F. Bowlby, vice president.

Engineering work on the project has already begun, with actual construction scheduled to get underway March 15 and completion date set at September 1, 1953.

Capacity of the Shell plant will be increased by one-third when the project is completed, Bowlby said. The work was necessitated by Shell's increased production in the Ventura Avenue field. It is the second major extension of the Ventura plant within the past five years.

Increased capacity will be used to supply Shell's Wilmington refinery with additional natural gasoline for conversion into motor and aviation fuels. This ties in with Shell's expansion program at the Wilmington refinery.



Refining sub-committee, to select exhibits in the Hall of Science at the 1953 International Petroleum Exposition, includes, chairman, W. J. Carthaus, vice president, Deep Rock Oil, seated center. Standing, are: Lee Haugen, vice president of refining, Cities Service; G. E. Wynn, vice president of manufacturing, Mid-Continent Petroleum; Luther Williams, Sunray; George Kinter, vice president, Tidewater; C. D. Hull, manager, Ponca City refinery, Continental; G. H. Westby, chairman, executive group, Scientific and Technical Committee, president, Seismograph Service; Harold M. Smith, Bureau of Mines; Dr. B. B. Weatherby, vice president, Amerada, and consultant to the general committee. Seated, C. F. Niessen, sales promotion manager, Mid-Continent Petroleum; C. C. Tate, manager of refining department, Phillips; Carthaus; Howard H. Belew, assistant to vice president, Skelly; and W. J. Fuchs, merchandising manager, Deep Rock.

New Ammonia Plant Set

Homer Reed, president of Brea Chemicals, Inc., newly organized subsidiary of Union Oil Company of California, announced his firm will lease and operate an especially designed $13,000,000 plant to be built at Brea, Orange County, for the manufacture of ammonia for western agriculture and industry. The ammonia will be made from natural gas taken from wells near the town of Brea.

C. F. Braun and Company has been selected by Amoniaco to construct the plant which is scheduled for completion in the summer of 1954.

Du Pont Assists Teaching Of Chemistry in Schools

A new program intended primarily to assist and advance the teaching of chemistry in American colleges and universities will be begun by the Du Pont Company next fall. Thirty-two institutions will receive new fellowships or grants for the next academic year as the result of a comprehensive survey by the company that revealed the need for such assistance.

In one plan under this program, grants have been made to 19 four-year private colleges to help them maintain their outstanding performance in the training of students majoring in chemistry. In the other, the company has awarded postgraduate fellowships to 13 universities to improve the teaching of chemistry to undergraduates.

Alcohol-Butadiene Booming

Due to increased scarcity of butanes and butylenes from petroleum sources, Reconstruction Finance Corporation is in the market for 15,000,000 gal of pure ethyl alcohol to supply, along with its stockpile of 20,000,000 gal of the same, the needs of four butadiene-from-alcohol units going on stream again right away. Two of these units are at Louisville, Kentucky, and two at Kobuta, Pennsylvania. These plants were shutdown when petroleum-derived butadiene was plentiful and considerably cheaper, a situation that is no longer true as of now. From a price of more than $1 per gallon for alcohol at the time these plants were shut down, competition between synthetic, foreign, and domestic fermentation alcohol has driven the price down to between 50 and 55 cents per gallon. Entry of RFC into the alcohol market may be the primary cause of Shell Chemical's boosting its ethyl alcohol price recently.

New Flow Control Announced

Pneu-Trol Devices, Inc., (Chicago) is now marketing a flow control valve for application with either air or hydraulic liquids. The firm claims the new valve has greater sensitivity, can operate under higher pressures than conventional valves. It says it should permit control applications that were formerly considered impossible. The valve is made in five pipe sizes ranging from ⅛ to ¼ in. Operating pressure is up to 5000 psi.

NACE Round Table Held On Corrosion Problems

For the first time at a national meeting of the National Association of Corrosion Engineers a round table discussion on refinery corrosion problems will be held. This session, to be held on the afternoon of Tuesday, March 17, at Hotel Sherman, Chicago, Illinois, during the NACE Ninth Annual Conference and Exhibition, will be moderated by A. E. Hernsberger of The Pure Oil Company. Questions raised are expected to relate to the use of inhibitors, refractory linings, corrosion of furnace tubes, inspection methods, cooling water corrosion, graphitization of steel, and cathodic protection of refinery equipment.

Two papers also will be presented. One of these, Hydrogen Penetration of Steel in Hydrogen Sulfide Solutions by T. Skei and A. Wachter, deals with the influence of a number of variables on hydrogen blistering effects such as those observed in equipment processing sour gas and gasoline streams from catalytic cracking units. Particular attention will be paid to the effects of ammonia and cyanide.

Two sessions will be held for the presentation of eight papers in the Chemical Industry Symposium.

"Effects of Structures and Phases on Corrosion of Steel" by F. A. Prange, Phillips Petroleum Company.

"Corrosion by Acids at High Temperatures" by R. F. Miller, R. S. Treserder, and A. Wachter, Shell Development.

"Use of All-Plastic Piping and Equipment in Technical Corrosion Protection," J. D. Huscher, American Agile Corporation.

"Behavior of Titanium in Sulfuric and Hydrochloric Acids," Warren W. Harple, Allegheny Ludlum Steel.

"Graphical Multiple Correlation of Corrosion Data," O. B. Ellis, Armco Steel Corporation.

"Resistance of Aluminum Alloys to Atmospheric Weathering," R. H. Brown and associates, Aluminum Company of America.

"Corrosion Study in a Salt Plant" by H. O. Teeple, The International Nickel Company, Inc., and a paper by James Collins of E. I. Du Pont de Nemours and Company.

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Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Unit for natural or induced draft furnaces.

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Research Lab Expanded By Petrolite Corporation

The Petreco Division of the Petrolite Corporation recently completed an addition to its research facilities at Webster Groves, Missouri. The new addition includes approximately 4500 sq ft of floor space, in a new, two-story reinforced concrete and brick structure. In the new laboratories are facilities for the fundamental investigation of electric fields and for the study of the chemical phases of the various electric treating processes developed by Petreco. Also there is an extensive pilot laboratory, where the various applications of electric processing are studied and developed. Supplementary facilities such as photographic equipment and dark room, fire-proof storage for hazardous liquids, maintenance shops, store-rooms, and office space are provided.

These additions were necessitated by the extensive studies now being carried on by Petreco in the field of electric petroleum processing. These activities are supplemented by specialized activities at the Petreco district laboratories in Houston, Texas, and Long Beach, California, and have been further extended in pilot plant activities in refineries. The electric petroleum refining processes include acid and alkali treating of lubricating and lighter distillate fractions, removal of salts and other impurities from crude oils, dehydrating of emulsified crude oils, sweetening of distillates, and improvement of stocks charged to catalytic cracking units.

U.S. Refining Capacity Gets Big Boost in 1952

The United States's oil industry boosted its refining capacity by more than 350,000 bbl per day in 1952, the American Petroleum Institute has reported. A survey made by the Institute showed that the industry had an operable refining capacity of 7,585,100 bbl per day by 1952, an increase of 356,000 bbl, or 5 per cent more than the 1951 close of 7,228,500 bbl. A further forecast of 157,700 bbl per day by next September 30, would raise the over-all total of operable refining capacity to 7,742,800 bbl per day.

Fluid Cat Cracker Goes On Stream in Canada

First model of its kind in Canada, and one of only two in the world, the "cat cracker" recently installed at Imperial Oil's Edmonton refinery is now on stream.

The new unit, known technically as a Model IV fluid catalytic cracker, was designed by the Standard Oil Development Company and installed by Foster-Wheeler Ltd., St. Catharines, Ontario, contractors for the $5,000,000 modernization program at the refinery. New vacuum distillation and gas recovery units are also in operation.

The entire modernization program was carried out with no interruption of the refinery's regular throughput, which will remain at 22,600 bbl a day.

Free World Raises Sulfur Output in 28 Projects

Free world efforts to increase the supply of sulfur, one of industry's most widely used raw materials, resulted in more than 900,000 long tons per year of new productive capacity in 1952.

This tonnage represents 28 projects in eight nations. The United States ranks first with 16 projects accounting for estimated production of approximately 700,000 tons. Canada is second with five for about 84,000 tons and Mexico third with two for 13,000 tons. Single projects are listed for Norway, 75,000; Sweden, 14,000 tons; Ecuador, 10,000 tons; England, 10,000; and Austria, 5000 tons.

The most recent projects to be placed in production are those of Freeport Sulphur Company, a Frasch-process operation in which the mining plant, built on a barge, uses heated sea water as the melting medium; Sinclair Refining and Shell Chemical for recovery of sulfur from refinery gas; Stanolind Oil and natural gas, and Canadian Industries, Ltd., for recovery of sulfur from smelter gas.

Largest of the new undertakings is that of Texas Gulf Sulphur Company at Spindletop dome near Beaumont, Texas. Spindletop, the fabulous oil field that made petroleum big business, has an estimated capacity of 400,000 long tons of sulfur per year. Although there are other Frasch-type mines being developed, this and Bay Ste. Elaine are the only new mines that have been completed this year.

Canada's biggest operation is that of Canadian Industries at Copper Cliff with a capacity of 40,000 tons of sulfur equivalent per year.

Shell Rebuilds Plant

Shell Oil Company, operator of the Sheridan, Texas, cycling plant, announced that work will begin immediately to repair the damage resulting from an explosion and fire recently. Company officials announced today that the Fluor Corporation has been awarded the reconstruction contract. The damage, estimated at $350,000, was confined to the plant's fractionation and distillation area. The construction work will take about four months, Shell officials say.

Deep Rock Expands Blending Packing Plant

Deep Rock Oil Corporation has expanded its blending and packaging plant at Cushing, Oklahoma, as the first step in a multi-million dollar modernization program planned for its lubricating oil manufacturing facilities.

Newest installations provide for improved packaging and materials handling facilities, a complete drum reconditioning line, greater warehouse and outloading capacity, and increased blending capacity.

In designing and constructing the plant, the chemical plants division of Blaw-Knox Construction Company utilized previously existing structures at the Deep Rock plant.

Existing buildings were reconditioned and a new 45-ft by 135-ft warehouse building was added. Base stock storage capacity was increased. A new power substation was installed. The plant's railroad spur was extended and a new loading dock was added.

Lone Star Gas Plans Parker County Plant

Lone Star Gas Company has begun construction of a $600,000 main line gasoline plant about one mile north of Springtown in Parker County, Texas, according to John M. Kindle of Dallas, superintendent of gasoline plants.

The plant, scheduled for completion about July 1, will have initial capacity for processing, 45,000,000 cu ft of gas daily. It was designed for expansion and can be enlarged to a capacity of 75,000,000 cu ft per day.

The plant, situated on a 12-in. main line, about 30 miles northwest of Fort Worth, will process gas from wells in Parker, Wise, Young, and Jack counties, and recover natural gasoline, propane, butane, and isopentane.

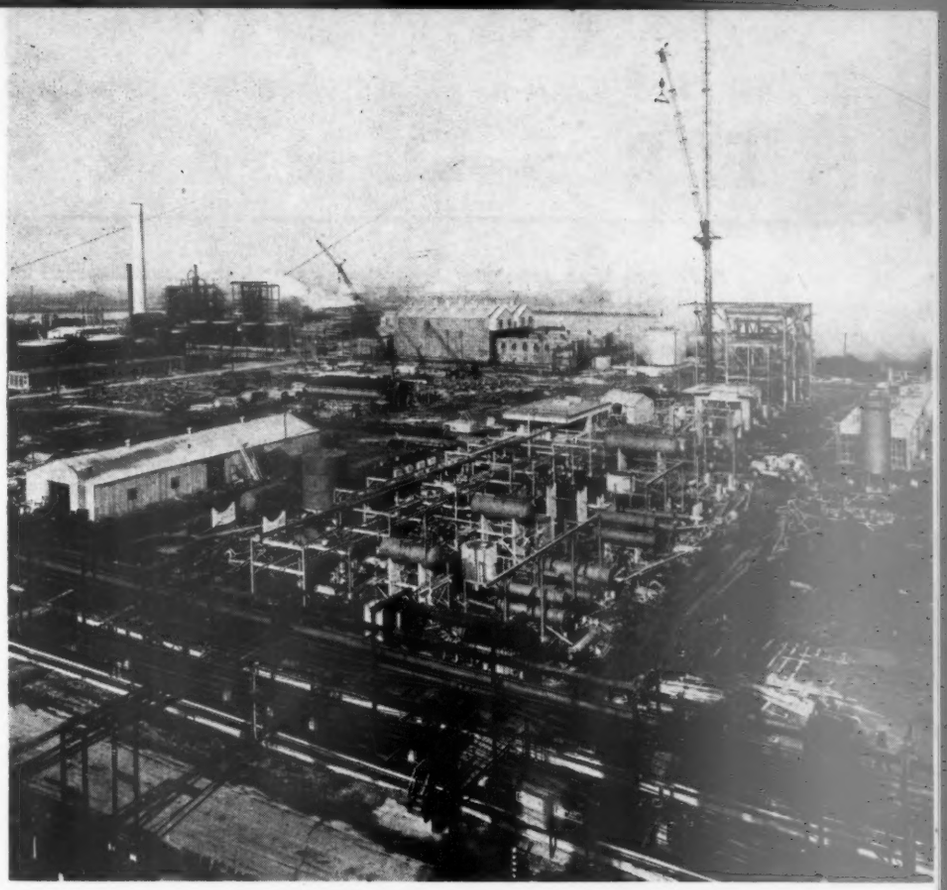
L. E. Todd, superintendent of Lone Star's Katy gasoline plant at Elmore, Oklahoma, is superintendent of construction for the Springtown plant. Don W. Hale, is project engineer; H. H. Saunders, construction foreman, and George Boggus is in charge of construction accounting.

Atlantic Refining Stages "Mileage Marathon"

A contest for drivers of sports cars, in which the winners were judged on the basis of the most mileage covered on one gallon of gasoline, was staged in Syracuse, New York, by The Atlantic Refining Company, recently. Mitch Sayres, driving a Volks Wagen, set the pace for the "mileage marathon" by registering 45.5 miles on one gallon of fuel.

Catformer Licensee Named

The Atlantic Refining Company has announced the addition of The United Refining Company, Warren, Pennsylvania, to its list of Catformer licensees. United is building a 2500 bbl-per-day Catformer for its Warren refineries with the Blaw-Knox Construction Company, as designer and contractor. Completion is scheduled for August, 1953.



Foundations for a gas recovery plant and hydrogen-sulfide removal equipment are well underway for Gulf Oil Corporation where The M. W. Kellogg Company, a subsidiary of Pullman Incorporated, is erecting the world's largest fluid catalytic cracker — a unit with a fresh feed capacity of 63,000 bbl per day — in Port Arthur, Texas. Steel work for the cracker may be seen in the background. Photo was taken November 1, 1952.

Ratings Fuel Manual Out

The second edition of the Amercian Society for Testing Materials manual of engine test methods for rating fuels incorporates all of the changes in the five standard methods for rating motor, aviation, and diesel engine fuels that have been adopted since their earlier publication in 1948. The six extensively revised supplements contain information on the best practices currently in use for laboratory facilities, installation of the engine test units, provisions for reference materials and electrical, water and air services, and the operation and maintenance of the units.

Standard Buys Site for Williston Basin Refinery

Standard Oil Company has bought a 900-acre site at Mandan, North Dakota, for its projected new Williston Basin refinery.

T. E. Stockdale, refinery manager, described the site as situated about three-quarters of a mile north of Mandan city limits, west of the Missouri River.

Contract has been let to the Lummus Company of New York City as prime contractor for construction of the new refinery. Final design of the 30,000 bbl a day plant is now complete and present plans call for construction to begin late in the spring.

Initial operation is scheduled for November, 1954, according to the Mandan refinery manager, who reported that preparation of the site for construction will probably begin in May.

Crude oil refining capacity of the new facilities was initially planned to be 15,000 bbl a day. The original design, however, was to permit later expansion to 30,000 bbl a day as crude oil production in the Williston Basin—and market demand—increased. In August, 1952, Standard officials decided to plan for construction of the refinery with a capacity of 30,000 bbl a day at the outset.

Construction Begins at AIOC Aden Refinery

Anglo-Iranian Oil Company's new oil refinery on Little Aden, 10 miles west of Aden on the Red Sea, will begin working by the end of 1954. The refinery will use crude oil brought by tanker from the Persian Gulf into a newly constructed port from which about 5,000,000 cu yd of sand must be dredged and a breakwater, jetties, and port facilities built. The new refinery will supply Anglo-Iranian's large marine bunkering trade at Aden, plus other markets in the Red Sea and Western Indian Ocean areas. The refinery and tank farms will occupy 270 acres of the peninsula on which Little Aden stands. Major plant, which will have an initial capacity of 100,000 bbl a day, will include two atmospheric distillation units and a power station capable of generating 30,000 kw.

XUM

REFINING AND GAS PROCESSING

PERSONALS

Clarke C. Miller has been appointed information co-ordinator at Standard Oil Company's Whiting, Indiana, research laboratories. Miller is in charge of information facilities and co-ordinates related activities between company and co-operating laboratories. He joined Standard in 1924 as a chemical engineer. From 1935 to 1945 he was chief chemist at the company's Wood River, Illinois, laboratory. He has been in charge of technical-information activities at Whiting since 1945. Miller is a graduate of Massachusetts Institute of Technology.

John A. Brooks has been appointed group leader in the pilot plant division at the Whiting laboratories of Standard Oil's research department. Brooks joined the company in 1946 as a chemical engineer. He is an alumnus of the Illinois Institute of Technology.

G. H. Hemmen has been transferred to the Union Oil Company's research and process department, Brea, California, as chief engineer. The following changes have taken place at the Oleum refinery:

Henry C. Meiners, manager, and **M. S. Thomson,** general superintendent, operations.

Thomas J. Walsh, a member of the Case Institute of Technology faculty since 1947, has been promoted to professor of chemical engineering. He holds four patents, the latest on manufacture lubricants, and has written numerous articles and papers.

Victor A. Denslow has been appointed manager of wax sales for Cities Service Oil Company (Delaware) with headquarters in Chicago, Illinois. Denslow was a chemical engineer with Atlantic Refining Company before joining Cities Service in 1949 as supervisor of the wax section, Technical Service Laboratory, East Chicago, Indiana.

E. W. Sanders succeeds Denslow as supervisor of the wax laboratory.

V. N. Bednarski, The Texas Company chemist, has been transferred to the producing-research section at Bellaire, Texas. He was formerly at the Signal Hill Laboratories at Long Beach, California.

Chester L. Babin, manager of Creole Petroleum Corporation's refinery in Amuay, Western Venezuela, has retired after thirty-three years of service in the United States, Colombia and Venezuela, the company recently announced.

Calvin Cooper, assistant manager of the refinery will replace Babin as of the same date. **F. K. Davis,** operations superintendent in Amuay, will replace Cooper; and **Montague Ball** was brought in from the company's refinery in Caripito, Eastern Venezuela, to replace Davis.

Babin began his career in the oil industry as a roustabout for Standard Oil of Louisiana in 1919. He was made assistant division manager in Maracaibo until February 1950, when he was transferred to Amuay as refinery manager.

Cooper was graduated from Loyola University in 1929. In 1948 he went to Venezuela to work for Creole Petroleum Corporation as maintenance and construction superintendent of the Amuay refinery. In January 1949, he was promoted to assistant manager of the refinery, where he has taken over the management.

Davis was graduated from Rice Institute in 1926. He began his experience in the oil industry with Humble Oil and Refining Company at Baytown, Texas, in 1926. In 1949 he joined Creole as technical superintendent of the Amuay refinery where he was promoted to operations supervisor in 1950.

Ball was graduated from The Citadel, a South Carolina military college, in June 1933. His Standard Oil experience began in 1923 at the company refinery in Charleston. In 1951, Ball was transferred to Eastern Venezuela as refinery coordinator. He has assumed the responsibilities of operations supervisor of the Amuay refinery.

Frank G. Moore has been named general traffic manager, Columbia-Southern Chemical Corporation. Associated with the transportation field since 1914, Moore has specialized on traffic problems of the chemical industry during the last 35 years. He has served as traffic manager for Columbia-Southern and its predecessor companies since 1934. Moore attended St. Pauls School, Polytechnic Institute and Johns-Hopkins University.

Charles A. Mengers, for many years assistant engineer of gas design for United Engineers and Constructors Inc., has been appointed engineer of gas design, taking the place of **T. B. Genay,** who has retired. Mengers attended Baltimore Polytechnic Institute and graduated from Cornell University in 1915 with the degree of Civil Engineer. After the war, he spent a year with the Du Pont Company in design work and then entered the employ of U.G.I. Contracting Company. He rose through the engineering department of this company, later the United Engineers and Constructors Inc., to his present position. Mengers has a long experience in design of manufactured and synthesis gas plants, having taken a prominent part in the design of some large gas plants.

John L. Ham has been named project manager in the metallurgical department of National Research Corporation.

Ham is a graduate of Pennsylvania State University. Prior to his coming to National Research, Ham was with the Raytheon Manufacturing Company.

Dominic J. Oriolo

Dominic J. Oriolo has been added to the process engineering staff of the Catalytic Construction Company in Philadelphia. His position will be that of project director on one of Catalytic's major operations. Oriolo came to Catalytic from Rohm and Haas where he spent five years as a plant development engineer dealing with design, operation, and technical service of chemical plants.

John A. Fuller, president of the Shawinigan Water and Power Company, of Quebec Power Company and of the St. Maurice Power Corporation, also of Quebec Province, has been appointed to the board of directors of the British American Oil Company Limited. Fuller is a director of Shawinigan Chemicals Ltd. and of Canadian Resins and Chemicals Limited, and is a director of the Bank of Montreal and of Rolls-Royce of Canada, Ltd. He is a member of the executive council of Canadian Manufacturers' Association and board of governors of McGill University, Montreal.

Harry L. Hilleary has been appointed group leader at the Wood River, Illinois, laboratory of Standard Oil Company's research department. **Max D. Napper** has been named group leader at the Casper, Wyoming, laboratory.

Hilleary joined Standard in 1947 after graduating from Cornell. Napper, a graduate of the University of Wyoming, joined the company in 1935.

Dr. Gustav Egloff, of Universal Oil Products Company, was invited by the French Institute of Petroleum, Paris, and by the French National Society of Engineers, to give a lecture there last month. Dr. Egloff gave a series of lectures in Spain during the month of December, and addressed the National Society of Chemists and Engineers in Madrid on January 2.

C. S. Gray, formerly assistant superintendent of Magnolia Petroleum Company's Pegasus natural gas district in West Texas, has been transferred to Smackover, Arkansas, as assistant superintendent of the Shreveport-Rodessa area of the Rusk natural gas district. **J. R. Leonard** has been promoted from assistant mechanical engineer of the natural gas department's construction and maintenance section, to assistant superintendent of the Pagasus district with headquarters at Midland, Texas.

P 615.635.

Corrosion — An Engineering Problem

Adequately engineered installations are assured only if designed and made by properly trained persons

MARSHALL E. PARKER*

THERE are some types of equipment whose selection and purchase may safely be left up to the purchasing department, and whose installation may be placed in the hands of competent technicians and craftsmen, working by the directions and instructions provided by the manufacturer. There are other kinds of apparatus that only can be selected by engineering studies made by qualified engineers, and which must be installed and placed in operation, and even maintained in operation, by these same engineers. The devices used to combat corrosion, using the principles of cathodic protection, fall into the latter category. Not only is it possible, even usual, for inadequately engineered installations of this type to fail of accomplishing their desired end, it is quite common for them to inflict actual damage and destruction, not only upon the structures for whose protection they were installed, but also upon "innocent" structures that happen to fall within their field of influence. Every practicing corrosion engineer knows of many examples of this kind of situation, but rarely can they be published and specifically named, for the obvious reason that those responsible for their installation do not want their ineptitude publicized.

The blame cannot always be laid on the "engineer" who designed the installation. All too often corrosion engineers are created by executive order, and men with little or no experience in the field are assigned to the task of developing a protective system. The first recourse of one who finds himself in this position is the published literature on corrosion. There he will find many technical articles on narrow phases of the subject, each one using many terms that are not defined, and which are supposed to be understood by the reader. Some of these will simply be mysteries; others will be understood, but erroneously. Consider, for example, the very common expression "pipe-to-soil potential." It appears, in some form or another, in virtually every article published on soil corrosion; yet almost none of them explain it, or give any hint as to how it is measured.

The corrosion-engineer-by-definition, then, seeing the importance of this quantity, sets out to measure it. As he is going to measure potential, he uses a voltmeter—usually one is available, and usually it is entirely unsuited for this application. Because he is measuring the potential between the pipe and the soil, he must somehow make contact with the soil. He is likely to use an iron rod, a copper ground rod, or a piece of galvanized pipe. To anyone who has any familiarity with corrosion measurements, it is immediately clear that he is likely to obtain almost any possible potential reading, except the correct one. Such behavior may seem, to those with experience in the field, to be incredibly naive, but it is a sober fact that just exactly that has been done, not just once but many times, by good, capable, men who have been assigned to a job for which they are not prepared.

If he doesn't read the literature, though, or if he reads enough of it to realize that there are numerous complexities involved, the next recourse of the corrosion-engineer-by-definition will be the equipment salesman. The kind of a deal he gets here depends entirely on the salesman, but it is a pretty good bet that he won't get a thoroughly engineered job—this is just too much to ask or expect. At best, he will get enough good advice to send him to a consultant who can keep him out of trouble; at worst, he will get an array of equipment that he can then proceed to misapply.

The Author

Marshall E. Parker now heads the Cormit Engineering Company, Houston, Texas, a newly organized company. He has been engaged in the practice of corrosion engineering as a consultant, and this new organization is designed to broaden the scope of his activities.

Consulting, surveys, and design are supplemented by facilities and personnel to make complete installations of cathodic protection systems. Parker has a BS degree from Sam Houston College and a BA from Rice Institute, and is a registered professional engineer in Texas. He has been associated with Pan American Pipe Line Company and Cathodic Protection Service.

Misapplications

The extent to which this misapplication can sometimes be carried is almost incredible. In one spectacular case, a rectifier had been consuming power (and graphite anodes) for 18 months. While it was doing this, it had been tremendously over-protecting 10 ft of pipe, and affording very mild protection to about 20 ft more. At the same time it was actively corroding 60 ft of pipe. Actually, it was a little worse than this, but the exact data cannot be given for fear of identification. This same unit, properly installed, could have afforded adequate protection to some 300 ft of the large bare pipe involved; in fact, it is doing so at the present time.

Admittedly, such extreme cases of misapplication and poor design are rare. Far more common are installations that are only doing part of the job they were intended to accomplish. Many of these will never attract attention by precipitating failures, but they will fail to satisfy because they are inadequate; or they will give apparently satisfactory service but at a cost greater than necessary. The installation of rectifiers at predetermined spacings is a frequent example of this type. Unless such units are installed at carefully selected sites, almost invariably they will be more costly than necessary, either in first cost or in operating costs, or in both. Nor can these sites always be selected by easily formulated rules; a thorough analysis—an engineering analysis—is required for optimum performance.

The principal deficiency responsible for these failures of inadequacy—and for a good many of the cases of inadvertent damage—is the substitution of what may be termed the technician's approach for the engineer's approach.

Technician vs Engineer

What, essentially, is the difference between a technician and an engineer? When should the one be used and when the other? Is a technician necessarily an inferior sort of person? The answer to the last question is a definite *no*. When the job to be done is a technician's job, then he is usually the best qualified person to do it—and this qualification may

EXCLUSIVE

in some cases be extremely strict and difficult to meet..

Essentially, a technician is one who has mastered to a high degree a particular set of skills. An air transport pilot is a good example. In trying and difficult circumstances, I, as a passenger, would much prefer to have the controls of the plane in the hands of a skilled and experienced pilot than in those of the engineer who designed it! On a more prosaic level, a competent electrician can be depended upon to do an adequate job of installing and connecting an electric motor, but who would be chosen to make the decisions involved in selecting the motor for a particular application, or in deciding whether to use individual motor drive, or perhaps even some entirely different source of energy?

An engineer is characterized by two essential attributes: An adequate knowledge of mathematics and the fundamental physical sciences, plus a high degree of specialization within one field of application: and a sense of responsibility toward his client (or employer), his profession, and society as a whole. Both of these attributes are necessary before a man can legitimately call himself an engineer, and both must be fulfilled in each listed particular. It is well to examine the separate parts of this description in some detail, with particular application to the corrosion engineer.

He must have an adequate knowledge of mathematics and of the physical sciences. Every engineer needs this bundle of knowledges and skills, regardless of the field in which he practices, for a very simple reason. As an engineer he is responsible for what he designs, not only insofar as its own functioning is concerned, but in the way it fits into, affects, and is affected by, everything in its environment. The key idea here is *responsibility*. The technician who installs an elevator in an office building is not subject to criticism if it is too small for its job, as long as the elevator works as it was supposed to work. Similarly, a technician can install a rectifier, and even build a ground bed for it that will enable it to deliver the specified amount of current; whether or not it protects the pipe line, or whether it inflicts damage on another structure in so doing, is an entirely different question—and is an engineering question.

The engineer needs a fundamental knowledge of *all* the sciences, because his work is in contact with that of other engineers, and must influence and be influenced by them. He must consult with them, and must be able to speak their language and to understand them. Furthermore, in his investigative work, he must repeatedly interpret the possible effect on the problem under consideration of all sorts of outside influences—he must consider *everything* that has any appreciable probability of affecting the situation under analysis.

Does this mean that an electrical engineer should be capable of designing a bridge? It does not mean that he should be able to do so with facility; though he should be completely capable of understanding the civil engineer's methods as used in bridge design. Probably, if he took enough time, he could design it himself. Certainly he possesses the abilities that would enable him, with further study, to become a civil engineer. During the first part of his college work he was taking the same course of study, but they parted company about junior year, each to pursue in greater detail his own field of specialization.

The Responsible Attitude

All the qualifications listed above are merely the tools of the trade. They will be of no avail unless they are properly applied, and the key to their successful application lies in the engineer's attitude. This is primarily one of responsibility. He must approach every problem with the attitude that he will have to live with it, and shoulder the responsibility of how it works, from then on. Consequently, he must feel a sense of responsibility to his employer, or client, to himself, the profession he represents, and to the community, or society as a whole. This means that it is very important to him that his works not only perform well for the owner, but that they do so without operating to the disadvantage of anyone else.

This attitude of responsibility to the community means that the engineer will call things as he sees them, whether the report be favorable or unfavorable to the beliefs and purposes of the owner. It also means that he will not countenance the installation of devices or equipment whose operation, under the existing conditions, will constitute a public hazard. Of course, in many instances his capacity is purely advisory. Having presented the facts and his interpretation of them, he can only recommend procedures. If the owner then persists in carrying out a project that the engineer cannot conscientiously recommend, he often has no recourse except to wash his hands of the affair—often to his distinct financial disadvantage.

Danger of Inadequacies

In the special field of cathodic protection, most of the disadvantages of failure to utilize the engineering approach make themselves apparent as inadequacies. Material and equipment is applied in such a way as to be relatively ineffective, or insufficient amounts are applied. There has been a little, but fortunately only a very little, out-and-out racketeering, in which grossly inadequate systems are installed, along with glowing accounts of the wonder of cathodic protection. An unfortunate aspect of the problem is that there is little to deter such practitioners from enjoying a continued profitable career, for often their systems are installed on structures that were not exposed to a particularly severe condition, and years may elapse before failures make the inadequacy obvious.

Even where there is no suspicion of deliberate fraud, the results of inadequate protection may be just as serious. Even reasonably competent personnel are entirely capable of installing grossly inadequate systems, and then feeling a completely unjustified sense of security until obvious failures make the inadequacy apparent. The hard fact is that cathodic protection, although it is deceptively simple in principle, can be astonishingly complex in practice. Two structures that appear to be almost identical may require radically different types of protective devices. It is too easy to overlook the fact that identity of structure and identity of environment are two different things, and every cathodic protection system must be designed far more to fit the environment than to fit the structure.

Nowhere is this more true than in the most common application of cathodic protection—to underground pipe lines. Two variables exist that completely preclude the use of cut and dried methods in this field. The first, and one which is often overlooked, is the variation in the conductance of pipe coating. Coating that has been applied under a rigid set of specifications, with competent inspection, can easily vary by as much as 200 per cent in this respect. The amount of protection needed, other things being equal, is directly proportional to this quantity. It can readily be seen, then, that only rough estimates of current requirements could possibly be made on the basis of the coating specifications. Such requirements can only be determined in the field, by actual test, under competent supervision. The tests themselves can be conducted by technicians —if no *great* deviation from anticipated values occurs; the interpretation must be made by an engineer.

The other variable is the soil, and the variation encountered here is on an even greater scale; commonly encountered values cover a range of more than a thousand to one! Fortunately, there is no great need for an elaborate analysis of the actual variations encountered, if the problem is that of protecting a reasonably well-coated line. The combined effects of the soil and the coating may be determined by a single test; a test planned by engineers, possibly executed by technicians, and interpreted by engineers.

This assumes a simple case. There remain to be considered the other, unexpected, variables—the crossing lines, subject to damage by the installed system; the effects of lateral connections, insulated or connected; the shielding effects of extraneous structures; and, finally, the inevitable abnormality of behavior, with no visible explanation. To these problems there must be brought all the available skill and experience; but what is needed most, and what ultimately is required for a satisfactory solution, is an understanding and an application of *basic principles*.

This must always be true. It is well-known among corrosion engineers that no two jobs are alike. Therefore it is impossible to effect a complete solution of any problem by a mere extrapolation of the experience gained on any number of others. As there seems always to be a novel element, there must always be needed the knowledge of basic principles—*and the habit of reasoning on basic principles*, which can only be found in the engineer. * * *

Pipe with concrete weights applied at approach to Trans Mountain's No. 4 crossing of the Fraser River west of Jasper.

Pipelining Across the Canadian Rockies

Delivery of Alberta crude to Pacific Coast in fall of 1953 will mark milestone in development of Canadian oil industry.

D. L. ROBERTS

COMPLETION of the $90,000,000, 718-mile, 24-in. Trans Mountain Oil pipe line this coming August, and the delivery by pipe line of Alberta crude oil to the Pacific Coast during October, will mark a milestone in the development of the Canadian oil industry. It will signify the establishment of economical petroleum transportation across practically the entire distance of Canada.

Ever since the current large-scale development of the Canadian oil fields — which began following the discovery of Leduc in 1947 — production has been restricted by the lack of sufficient transportation. The importance of economical transportation can clearly be appreciated when one realizes that two-thirds of the Canadian market (eastern area) is some 2000 miles removed from the oil fields and the western market is more than 700 miles from source of supply.

Although proved reserves have increased from 46,000,000 bbl in 1946 to almost 2,000,000,000 bbl — more than 40 times — and more than $1,000,000,000 has been expended in the exploration and development of the Canadian oil industry, production has increased from only 19,000 bbl per day to approximately 165,000 bbl per day, or less than nine times.

The completion of the Interprovincial pipe line late in 1950, to transport crude oil eastward through the Prairie Provinces of Manitoba and Saskatchewan and to serve part of the Ontario market, was the first step designed to eliminate this bottleneck. This 20-18-16-in. pipe line from Edmonton, Alberta, to Superior, Wisconsin, at the head of the Great Lakes had an initial capacity at Superior of about 75,000 bbl per day. The maximum capacity at Superior was increased to approximately 90,000 bbl per day during the past summer by the looping of the 16-in. section.

From Superior large lake tankers have picked up the oil and during the summer months transported it to refineries at Sarnia at the foot of Lake Huron. This has caused wide fluctuations in the demand for Alberta crude and interfered with the orderly delivery of crude oil to the refineries at Sarnia. To further overcome this inconvenience and to provide for the transportation of large quantities of crude oil for the Ontario market, last December plans were annnounced to connect the terminal at Superior with the refineries at Sarnia by a 30-in. pipe

EXCLUSIVE

Raft made of 24-in. pipe joints for ferrying equipment 750 ft across North Thompson River near Avola. Raft weighed 70 tons and could carry 50 tons.

line, thereby making it possible to transport crude oil throughout the year from the Alberta and Prairie Province oil fields to the refinery facilities at Sarnia.

In February, 1952, just 12 months ago, in order to provide economical transportation facilities westward to British Columbia and the Pacific Northwest, construction was begun on a 24-in. pipe line across the Rockies over an all-Canadian route between Edmonton and Vancouver on the Pacific Coast.

Being built by Trans Mountain Oil Pipe Line Company, the pipe line's initial capacity with three pumping stations will be 120,000 bbl per day. By the construction of additional pumping stations, this pipe line ultimately can transport economically well in excess of 200,000 bbl per day and will serve not only the British Columbia market, but also the Pacific Northwest.

Early in November plans were announced for the extension of the pipe line from the main trunkline, connecting the Alberta crude oil fields with the Pacific Coast, across the Canadian-U. S. border from Sumas, British Columbia, in a southwesterly direction toward Seattle. At the same time, General Petroleum Corporation announced that it would begin immediately construction of a 35,000-bbl per day refinery at Ferndale, north of Bellingham, Washington.

This new refinery, the first modern full-scale oil refinery in the U. S. Pacific Northwest, will process Canadian crude oil and transport it through Trans Mountain's extension by a lateral from Laurel to the Ferndale site. The refinery will cost approximately $35,000,000.

The extension and lateral will cost approximately $2,750,000 and will be built in behalf of Trans Mountain during the fall of 1953 to be ready by the time the new refinery is completed in the fall of 1954. The opening up of the Pacific Northwest market by the construction of this initial refinery utilizing Canadian crude will relieve the demand for California crude oil and oil products. Immediately this will tend to bring all Pacific Coast requirements for crude oil into balance.

Because of the terrain through which the Trans Mountain Oil pipe line is being built and the weather that is being encountered, the construction program has been broken into two seasons. The first began a year ago in February, 1952, when preliminary work, including the obtaining and clearing of the right-of-way was begun. It lasted until early December when heavy rains and snows forced the last spread operating in the area to close down for the winter. The second season will begin this spring as early as weather conditions will permit and will continue until the main trunkline between Edmonton and Vancouver, together with terminals at each end of the line, are completed.

Between the close of the first and the beginning of the second actual construction season, clearing and grading crews operated, preparing the right-of-way for early resumption of pipe laying. Various stretches infringing on the highways were worked upon. The last two main river crossings were pushed forward and work within the three pumping stations continued to go ahead — all aimed at the August, 1953, completion date.

As plans for the second season were completed, the accomplishments of the first construction period were reviewed. They had been substantial.

The entire 718 miles (slope distance) of the line had been located and legal surveys had been completed on all but a few miles.

All but a short portion of the right-of-way had been acquired.

The necessary permits from governmental authorities and other regulatory bodies had been applied for and received on all 1952 construction and a major portion on 1953 construction.

Three hundred and thirty miles of the pipe line had been laid, including 50 river crossings, 56 highway crossings, and 24 railroad crossings. Not a single day's shut-down time was chargeable during the first season of construction by the contractors due to the lack of right-of-way or pipe or permits.

Work at the three pumping stations, situated at Edmonton, Marlboro, and Kamloops, had advanced so far before the winter closed in as to permit engine and pump setting and interior piping and electrical installations to be carried forward during the winter.

The tank farms at Edmonton and Burnaby had been graded and the actual erection of tanks at Edmonton had begun. Erection of the tanks at the Burnaby tank farm is scheduled to begin early this year.

Design of the Barnet dock had been completed and plans were under way for various ancillary installations, such as the pressure relief stations, scraper traps, bypass valves, valve housings, highway marker signs, etc.

Even with this work accomplished, the larger portion of the job lay ahead. Fifty-five per cent of the line was yet to be built. The pumping stations were less than half completed, while the tank farms could only be considered as well begun. The marine loading facilities at Barnet on Vancouver Harbor, the pressure relief stations, and a host of minor items necessary to provide a finished pipe line, were not even begun and nothing had been done on testing of the full 718 miles of the pipe line, which cannot begin until some time this spring.

During the fall and winter the radio communications survey was carried out for the purpose of determining suitable frequencies for pipe line operations over the Canadian Rockies. These tests consisted of setting up, transmitting, and

The Author

D. L. Roberts was graduated from the South Dakota School of Mines in 1933 with a degree in civil engineering. He joined Bechtel on the Canol Project in Edmonton in 1942 and has been associated ever since with various Bechtel activities throughout the world. Late in 1950 he was placed in charge of preliminary reconnaissance, cost estimating, engineering, designing, field surveys, and construction planning of Trans Mountain. Since August, 1951, he has been Canadian Bechtel, Ltd's., project manager for designing, engineering, and supervising Trans Mountain. In December, 1952, he was elected a director of Canadian Bechtel, Ltd., of which he was a vice president. He is a registered professional engineer in Alberta and British Columbia. His home is in Vancouver.

Follow-up welder working near Red Pass, British Columbia.

receiving from various base stations and from a mobile unit at intermediate points. Upon the completion of area preliminary tests, final tests will be conducted over the entire line prior to determining the permanent radio equipment desired.

The entire operation, in behalf of Trans Mountain Oil Pipe Line Company, is being coordinated by Canadian Bechtel, Ltd., acting as Trans Mountain's agent. As such, Canadian Bechtel, Ltd., has been and is responsible for the designing and engineering of the entire project and is supervising the actual construction.

During the first season, five pipe laying spreads were in operation. One was under the direction of Mannix, Ltd., of Calgary, operating along the center section of the pipe line. Three were under the direction of Comstock Midwestern, Ltd., of Toronto, two of which were operating in the Mt. Robson and Jasper Park areas and one through the Fraser River Valley. The fifth spread operated on the extreme eastern portion of the line from Acheson to Edmonton under the direction of Canadian Pipeline Construction Company, Ltd., of Calgary.

Before actual construction began, a 60-ft right-of-way was obtained. Clearing of this right-of-way begun in February, 1952, has continued ever since, and will not be completed until late spring of this year. Trans Mountain and approximately 3000 landowners — private, municipal, and government — will have entered into contracts before the clearing is completed.

These agreements convey to Trans Mountain the privilege of laying the pipe along the route selected and, in turn, bind Trans Mountain to pay for damages, if any, to crops, fences, and other property of the landowner during construction and maintenance of the pipe line.

Along the route between Edmonton and Vancouver more than 150 sidings have been established where the pipe, transported by rail from fabricating plants primarily in the San Francisco Bay area, has been stacked and is being stacked throughout the winter in anticipation of the resumption of stringing and welding during the coming spring and summer months.

From these sidings, specially-constructed trucks string the pipe alongside the yard-wide ditch. After the pipe is welded, X-rays are made of a representative number of the welds. If any welds are not up to standard and fail to meet the test, they are cut out and re-welded.

Following the welding, rust, and scale are removed from the pipe and a protective priming coat is applied. Then the coat-and-wrap machine, which is self-propelled, applies a coal-tar enamel of a temperature of about 475 F, then wraps the pipe with a glass fiber matting and on top of that asbestos felt.

To insure that there are no breaks in the wrapping, a holiday detector is passed over the wrapping. If any flaws in the wrapping exist, this device gives an automatic electrical signal.

In rock cuts, to protect the pipe further, an extra wrap of asbestos felt, known as "rock shield," is applied.

After this operation is completed, the pipe is lowered into its trench and the earth is replaced by bulldozers and draglines, restoring the earth to its original state and thus permitting farming or other operations to be resumed at once on the surface.

So that the flow of crude oil can be shut off anywhere and at any time if necessary, valves are being installed at distances varying from 10 to 20 miles. These valves stand about 9 ft in height and are welded into the pipe line. They weigh 9000 lb and the total installed cost is about $15,000 per unit.

In order to insure maximum safety prior to the pipe line's being filled with crude oil and placed in service, the entire line will be tested with air. This testing operation, which will be performed with air for the first time on a major crude oil pipe line, will add substantially to the overall cost of construction.

The pipe line is being buried throughout its entire 718-mile route. In agricultural areas the pipe is buried so that the top is 30 in. below the surface of the ground. In rocky areas the top of the pipe will be 24 in. below the surface, and it will be 8 ft or more below the beds of approximately 72 rivers, streams, and creeks that must be crossed.

As the various spreads have become closely coordinated teams, laying progress accelerated. During October at one time about three miles of pipe were being laid per day. The construction schedule, however, was interrupted contin-

Ernest Woodward, Canadian Bechtel land agent, views valve on Trans Mountain system one mile west of Vavenby.

uously throughout the summer and fall seasons due to difficulties encountered in weather and terrain. For instance, one spread operating east of Jasper Park had to fight its way through a 9800-ft swamp. Another spread was delayed because it had to move all of its equipment by rail around two impassable rivers, while a third spread was slowed down as a result of swamps caused by heavy rains.

The clearing crew in the Coquihalla Canyon had to stop operations during the summer for a time because of extreme fire hazards and dry weather, while survey parties at the same time were permitted to continue. Again in December, the clearing and grading crew operating in the Coquihalla Canyon had to move out because of heavy snows.

When conditions of these types have occurred, efforts have been made to move various parts of the spread to areas where weather conditions did not hamper operations. Such moves, however, have been expensive and have caused delays in the number of miles of pipe laid.

During the entire job operations have been scheduled to take advantage wherever possible of normally anticipated weather conditions. In this connection, the major crossing of the Fraser River near Port Mann, about six miles east of the pipe line's western terminal at Burnaby, is being laid this winter when the waters are at their lowest. This is a 5700-ft span, which includes 2500 ft of single line gunite-coated ½-in. crossing pipe buried with a maximum of 15 ft cover. More than 300 ft of pipe were installed in casing under the Canadian National Railways' main line and yard tracks just south of the river. In addition, almost 2000 ft of line pipe were installed in a swampy approach area north of the river.

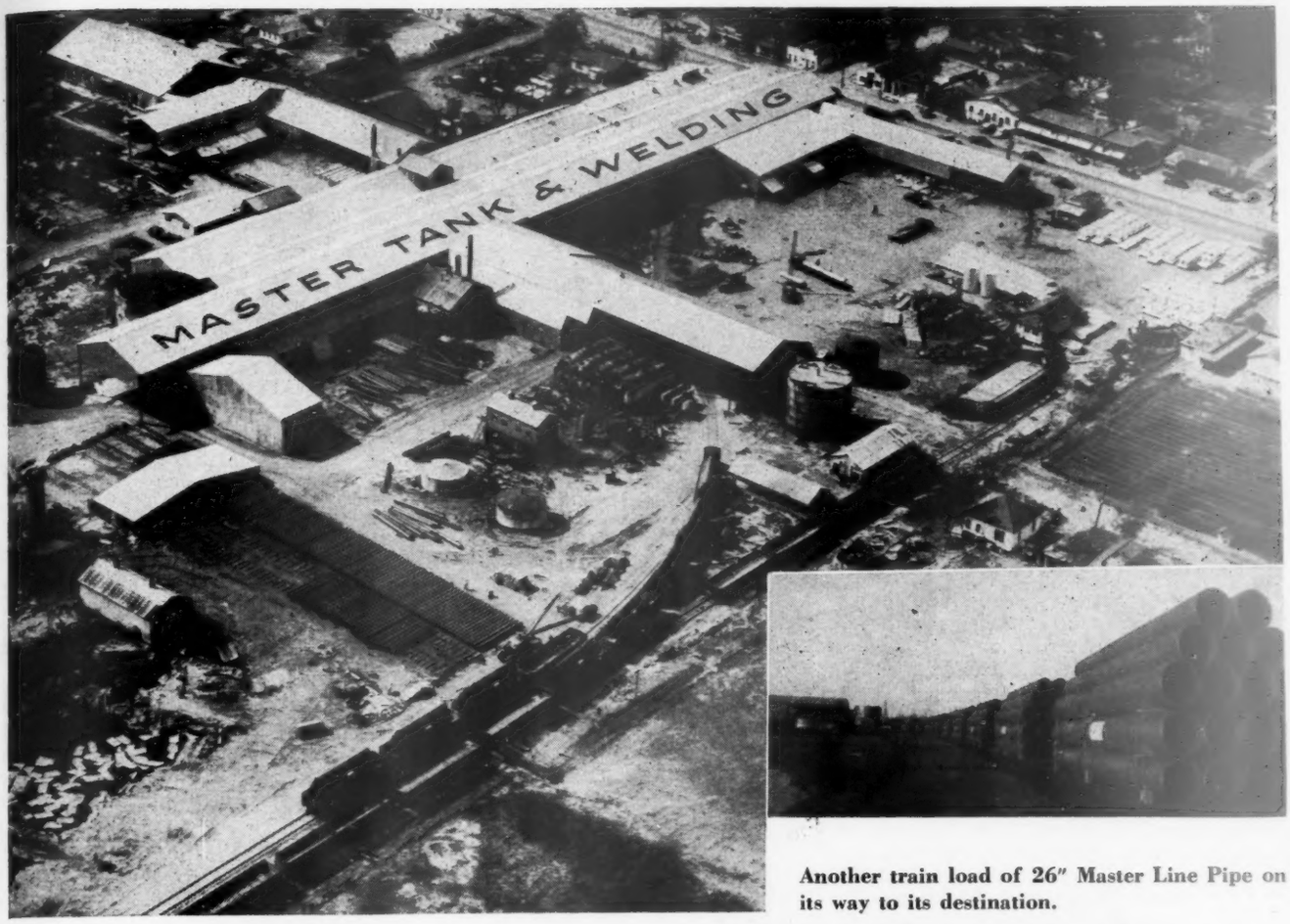
In another Fraser Valley area permits for construction were granted for putting in a canal crossing at Sumas on the basis that the installations would be made early in September. After completion of the Sumas Canal crossing, lowering in was slow because the spread was working in an irrigation district where ground water had to be held down by pumping. Approximately 15,000 ft of this section were almost level. The pipe line here was filled with water to hold it in the ground. Shortly after this work was completed, weather conditions prevented the spread from moving forward as scheduled, and it jumped 14 miles to take advantage of more favorable conditions existing on that portion of the line.

Pre-heating equipment was provided for the spreads working in the mountains so that operations could continue as late in the fall as possible. Although in general the weather was favorable, through September and October, during the last two weeks in November the temperature around Edmonton and Marlboro went as low as zero. In other areas temperature was not quite so low, but several days were below freezing.

Late in September the spread working from Yellowhead Pass to Blue River came to the end of the section it was scheduled to complete last fall. This gang was then split. One part moved back to close a three-mile gap west of Mt. Robson Park and the other portion completed three crossings of the Fraser River in its upper reaches.

During the latter part of the construction season last fall, work was hampered by lack of transportation or living facilities near points where some of the spreads were operating. For instance, the main portion of one of the spreads working east of Jasper Park was required to travel a total of 140 miles to and from work each day. The stringing and right-of-way gangs were housed in Edson, but the pipe line gangs were housed in Jasper. This naturally interfered with their daily production, but there were only a few miles left and every effort was being made to get as

Backhoe digging trench on hill west of Jasper.



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much pipe as possible in the ground before the snow flew. After the fall construction season ended, the camps were shifted.

Clearing and grading were done last fall through a 35-mile section between Gosnell and Blue River. This section has considerable side-hill work and at least 17 miles are covered with heavy cedar timber. It is also in a heavy snow area. Thus, it was desirable that the right-of-way be cleared and graded last year so as not to delay pipe-laying operations early this spring.

Throughout the operations one of the principal problems has been that of obtaining right-of-way. At certain times it has been a bottleneck, but in general clearances have been made in ample time to permit the pipe line gangs to weld and lower in the pipe in accordance with established schedules.

When Trans Mountain is completed in August and Alberta crude oil begins to reach the Pacific Coast, every barrel of such crude that is utilized in the Vancouver market or in the Pacific Northwest will reduce the demand on California crude by an equal amount. The entire program is being expedited so that Alberta crude oil will become available and thus contribute substantially toward bringing into a normal balance the overall supply and demand on the Pacific Coast.

The principal oil companies participating in Trans Mountain Oil Pipe Line Company are: Canadian Gulf Oil Company, Imperial Oil, Ltd., Shell Oil Company of Canada, Ltd., Standard Oil Company of British Columbia, Ltd., Union Oil Company of California, and Richfield Oil Corporation, along with S. D. Bechtel, and nominees of Canadian Bechtel, Ltd.

To these groups were sold at the outset 800,000 of a total of 1,500,000 shares of capital stock, while 250,000 were purchased by 14 Alberta oil producing companies. These companies comprise: Anglo-Canadian Oil Company, Ltd., Bailey Selburn Oil and Gas Company, Ltd., (formerly Selburn Oil Company), The Calgary and Edmonton Corporation, Ltd., Calvan Consolidated Oil and Gas Company, Ltd., Central Leduc Oils, Ltd., Del Rio Producers, Ltd., Home Oil Company, Ltd., Hudson's Bay Oil and Gas Company, Ltd., National Petroleum Corporation, Ltd., Pacific Petroleums, Ltd., Royalite Oil Company, Ltd., Security Freehold Petroleums, Ltd., Trans Empire Oils, Ltd., and, Triad Oil Company, Ltd.

Dragline cutting channel for No. 4 crossing of Fraser River.

X-Ray equipment in use on Trans Mountain line.

In addition, 450,000 shares initially were sold to the general public. In all, there were more than 6000 sales to the public, of which 4500 were for 50 shares or less. The average was about 75. Of this issue, approximately 113,000 shares were sold in British Columbia, 80,000 in Alberta, and the balance in other Canadian provinces.

S. D. Bechtel is chairman of Trans Mountain; Robert L. Bridges, president; H. H. Anderson, vice president and general manager; Sidnev M. Blair, vice president; I. G. Wahn, secretary, and R. F. B. Taylor, treasurer. Operating offices for Trans Mountain have been established at 1070 Hornby Street, Vancouver, British Columbia.

In Canadian Bechtel, Ltd., the president is Van W. Rosendahl. Chief members of the Vancouver staff, currently working with the project manager, are: J. H. Burroughs, construction manager; H. F. Waste, engineering manager; B. D. Bohna, project engineer; C. L. Adamson, pump station superintendent; Charles L. Crow, materials superintendent; E. L. Guard, lands manager; William C. Ralston, administrative manager. Canadian Bechtel, Ltd's. project office for Trans Mountain is at 425 Howe Street, Vancouver. ***

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Two separate coats with no bond between neutralize shear stresses and lateral shocks

RICHARD SNEDDON*

In the capacious and well equipped pipe yard of the Southern California Gas Company at 48th and Staunton Streets in Los Angeles, California, there are many systems and devices of interest to the pipeliner. Particularly, however, attention should perhaps be directed to a self-developed and distinctive process of protective coating that has been carried on most effectively for about 16 years. Needless to say, in a metropolitan area where lines traverse busy city streets and the prospects of excavation, especially for retreatment or replacement, must be held to the very minimum, the adequate protection of the pipe in place is highly important both from the viewpont of convenience and economics.

Without immediately going into details on the manner of application, it might be explained that the principal difference between the coating under consideration here and others commonly used for the protection of line pipe, is that in this instance *two separate coats are applied with no bond between them.* They are, indeed, separate in the true sense of the word in that the outer coat may actually move laterally in relation to the inner one. Thus, besides possessing all the inherent protective virtues of the ingredients of which it is composed, the dual coat is able, in addition, to neutralize to a considerable extent the effect of shear stresses or lateral shocks. This, of course, is because the outer coat absorbs much of the stress or shock in actual motion and does not transfer it to the inner coat. It is quite obvious that this feature offers no special protection against direct penetration, for example, by a sharp-edged rock or stone, but whatever the nature of the undesirable force, if it be directed laterally, the ability of the outer coat to change position in relation to the inner (bound) coat, constitutes a measure of defense.

Another equally and perhaps even more important protective feature of the acetate wrap is that it shields the inner coating from direct soil contact and to some extent also from the effect of ground water. At the same time, it helps to preserve the oils in the inner coat while those in the outer coat have no such retainer and consequently deteriorate more rapidly.

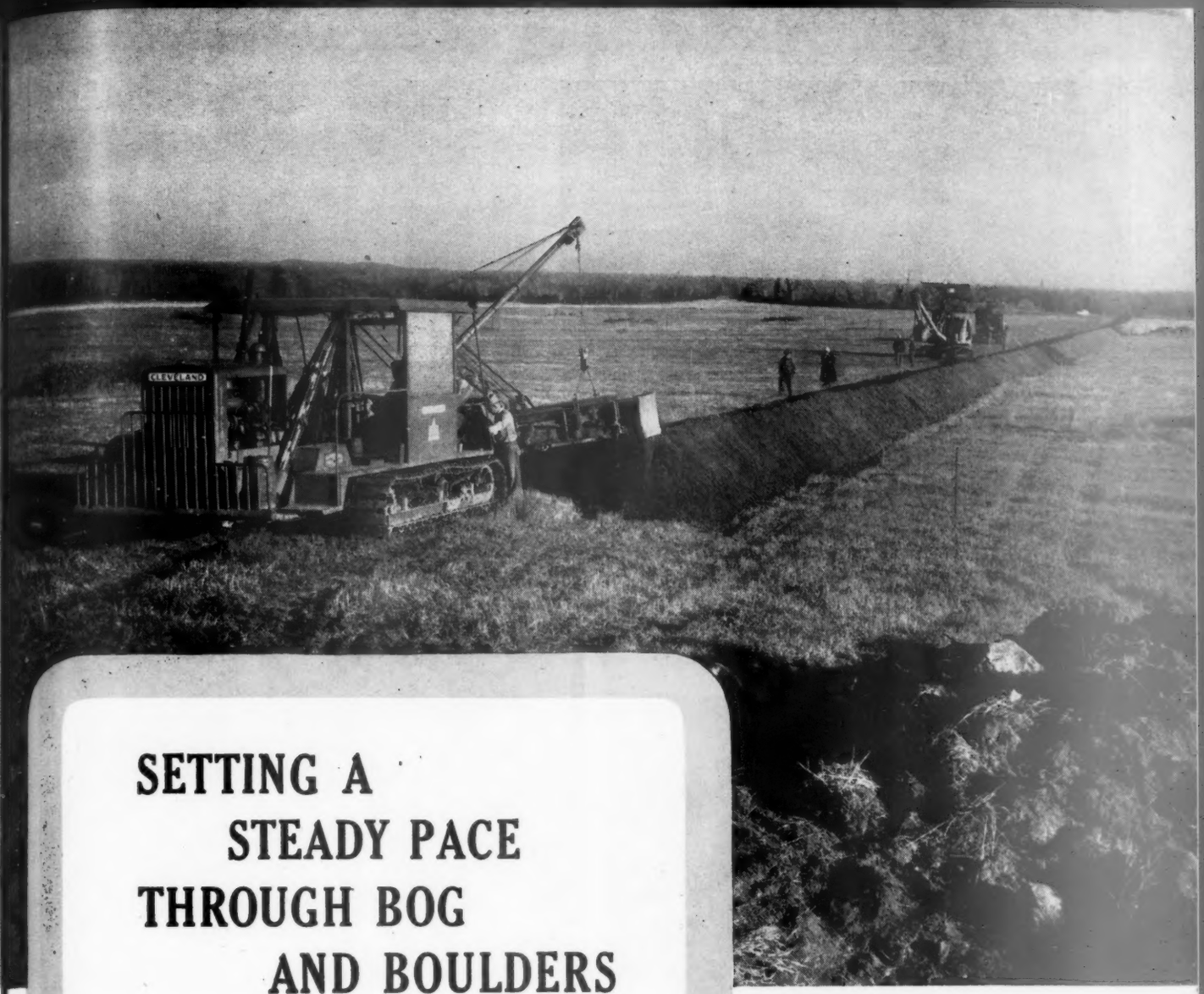
The two-phase coating actually consists of: (1) An asphalt-base primer; (2) a 1/10 in. layer of asphalt; (3) a wrap of cellulose acetate† bonded to the asphalt; (4) a cellulose acetate wrap that remains unbonded to the preceding wrap; (5) a 1/10-in. asphalt layer, and (6) a final wrap of paper or pipeline felt (asbestos). The two plastic wraps are kept apart by simply applying them at a temperature below their melting or softening point, i.e. 400 F, and in effect they divide the total applications into one fixed and one movable layer. The thickness of the cellulose acetate wraps is .00088 in. each, and how well they perform their function is demonstrated in the facility with which the inspectors can cut out a section of the outer layer without disturbing the inner one.

Experience indicates that this species of coating does have a definite protective value. We noted some accelerated tests in which short lengths of pipe were coated with the combination as described and were given a final coat of bentonite clay. These were then exposed to the elements for some time, and it is to be observed that as the bentonite dried and peeled, it had a tendency to lift some part of the outer layer but in no way affected that which was bonded to the pipe. As the pipe samples were merely set in a rack and were not buried, this is not at all indicative of what might happen to the coatings when they are permitted to remain underground for protracted periods, but it does show the independence of the two distinctive layers, and to a minor extent the virtue of the cellulose acetate separation. Although no claim is made for any protective value in the cellulose acetate itself, it would seem from close examina-

*Editor, Pacific Coast.

†Lumarith, made by Celanese Corporation.

EXCLUSIVE



SETTING A STEADY PACE THROUGH BOG AND BOULDERS

This Cleveland trencher model 320, equipped with a Caterpillar D8800 Engine, is working on the 1,600-mile Lake Head pipe line near Floodwood, Minn. Let's hear what Mr. Carl C. Anderson of Anderson Bros. Corporation, Houston, Texas, has to say: "Difficult terrain makes the going rugged. This post-glacial region has a great deal of wet bog country. However, the greatest obstacle is the frequent masses of buried rock and boulders along with many tree roots. The D8800 has been performing through all this rough going without a hitch. It is very economical on fuel and oil."

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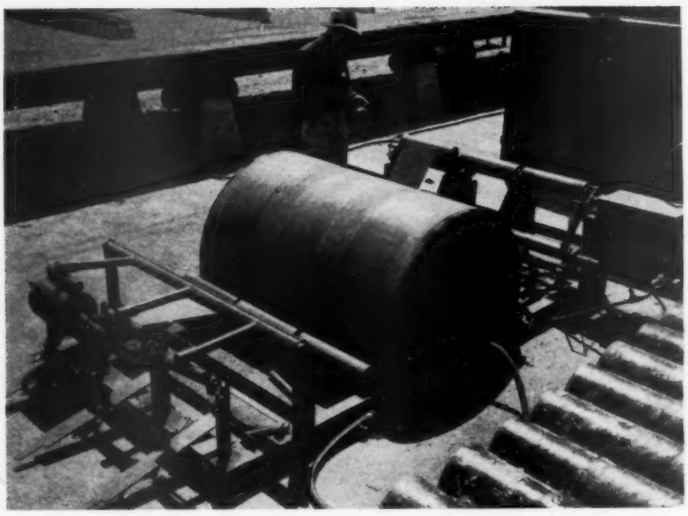
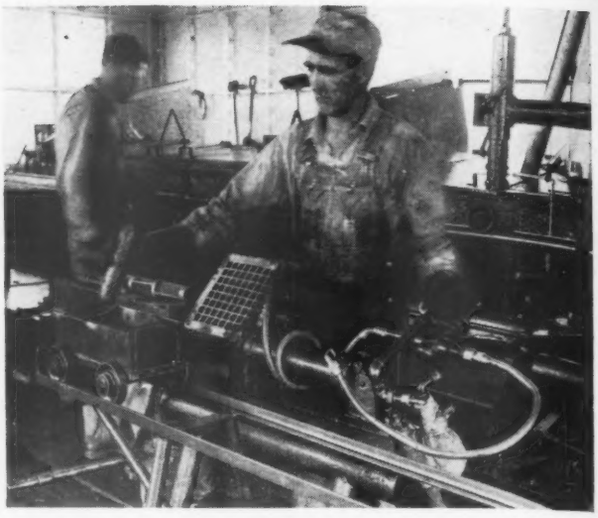
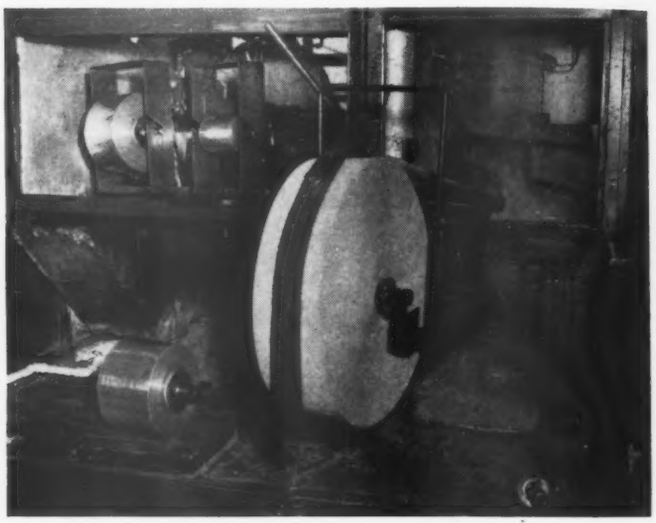


Felt dryer in which felt is exposed for 11 to 15 seconds at approximately 450 F to remove moisture and any light ends remaining in the saturant.



Pneumatic ram that is employed to clean off the outside pipe connectors. They are carried to the ram by the small manually controlled carriage shown at the left.

View of the intermediate carriage of large machine, which supports the two ends of the pipe. This obviates the necessity of using pipe connectors.



Small pipe coating and wrapping machine, showing application of the two Lumarith rolls and Kraft paper. The latter is given a hot dip in same asphaltic material as the main coats.

George E. Munson, pipe processing foreman, here demonstrates how the two Lamarith layers remain separated. The top coating can be completely removed without disturbing the inner bonded coating.

Quality control inspector, O.A. Lopez, cuts out a section of a reject to determine the extent and nature of the irregularity.

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HOT DOPE

Straight from the Kettle on *PIPE PROTECTION*

★

By Boyd Mayes

• A friend called up recently to learn why we'd missed out on several miles of big-inch that was going down almost under our nose. We told him we'd made an honest bid on the job, figured on a fair and reasonable profit, but had lost to a bid that couldn't, even by slight-of-hand performance, do more than break even on the job. He asked why we didn't underbid the cost and chunk in enough "extras" to make our profit. We've got a stock answer for that one: In more than a quarter of a century of doing a creditable job for the pipe line industry we've followed the same old policy: "We refuse to laugh our way into a job, then cry our way out!"

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tion of the test samples already mentioned that it does have a shielding influence that may, however, be negligible when the pipe is buried. In any case, its function is largely to permit the independent movement of the outer portion of the coating, which it certainly does.

Practically all coating done by Southern California Gas Company since this system was adopted has been done in the yard. Three pipe coating and wrapping machines are available for the work, all designed by company engineers under the direction of W. C. Hall, general foreman of the pipe yard. The smallest machine handles ¾-in. to 1½-in. pipe and coats approximately 25,000 ft in an 8-hr shift. The intermediate machine takes 2- to 6-in. pipe at a rate of 10,000 to 11,000 ft per 8-hr shift. A large machine capable of taking 4-in. to 30-in. in doubles, turns out an average of 8000 ft in 8-hr. Although most of the pipe coating for the company's distribution department is done in its own yard, a considerable quantity of large diameter pipe is coated by contractors with other types of coating. Almost all, indeed, of the large pipe used for gas transmission falls in this category and does not, thus, present any data on the value of the cellulose acetate wraps.

These machines are basically the same regardless of size. They are fully automatic and are driven by variable speed motors. They are equipped with breakdown tar kettles, thermostatically controlled between 370 and 400 F, each provided with agitators to keep the hot fluid in motion. The entire operation is continuous, the asphalt streams, the cellulose acetate rolls, and the paper roll being so spaced and timed as to constitute a single well-integrated operation. The final paper wrap is hot dipped in the same asphaltic material as is used for the other asphalt coats in order to devetlop a better bond between the final wrap and the preceding application.

In general, the routine is smooth and uninterrupted, and the main auxiliary equipment consists of a pneumatic ram for cleaning off the surface of the outside pipe connectors; a small manually operated carriage that transports the connectors from the opposite end of the coating unit to the immediate vicinity of the ram, and a drum in which the felt wrap is exposed for a few seconds at 450 F to remove any absorbed moisture or light fractions that might be present in the saturant. This last is to assure a good bond between felt and asphalt and to prevent the subsequent formation of blisters. It should perhaps be noted that although there is some doubt as to the presence of light fractions, or their effects when they are present, there is total agreement on the necessity of eliminating moisture. The heater, incidentally, is a gas-fired unit, and the re-rolling of the felt is accomplished by an air motor.

There seems to be little doubt that the coating and wrapping system employed by Southern California Gas Company is an effective one. Many inspections have been made since it was first adopted, and as a result of these, some modifications have been made both in material and method. The use of the two successive wraps of cellulose acetate have given a very satisfactory separation without apparently introducing too much friction between surfaces when movement does take place. The result is that the life of the pipe is definitely prolonged. It is not possible to state to what degree pipe life has been extended, because of the lack of parallel experience with conventional coatings in the same areas, but there appears to be ample evidence that the idea of confining lateral shocks and stresses to a more or less independent outer lamination is a sound one.

If, as appears from these observations, there is definite virtue in the double acetate wrap, there would seem to be justification for the studied development of asphaltic coatings that can be worked at low enough temperatures to avoid fusion of the two. At present, fillers added to asphalts in many instances require application of the asphaltic coat at temperatures above the softening point and approaching the melting point of the acetate. This increased temperature tends to drive gases, probably occluded, from the acetate and so form bubbles in the coating. Conversely, of course, it might be possible to develop a modification of the cellulose acetate that would resist softening or melting at higher temperatures.

The matter of providing maximum protection to pipe lines against the ravages of electrolysis, corrosion, abrasion, and other deleterious influences has long been of prime concern to pipe line engineers. In theory, the *sliding overcoat* is a thoroughly rational way of eliminating an appreciable part of the normally expected wear and tear on pipe lines, and in practice it seems to be doing just that. It is of considerable consequence that a large organization, to which protective measures are of the utmost importance, has employed the system described with apparent satisfaction for the last 16 years, and with some minor refinements is still using it. This is even more significant when the aforesaid organization is one that has long been noted for its research consciousness, and particularly research in the divers phases of pipe line transportation and transmission. ★ ★ ★

Statistics of Natural Companies Issued

The Federal Power Commission has released for distribution the 1951 edition of its annual publication "Statistics of Natural Gas Companies." The current edition reports the 1951 operations and the status at the end of the year of the 140 natural gas companies filing annual reports with the commission.

Copies of "Statistics of Natural Gas Companies," 1951 edition, consisting of 200 pages bound in blue cloth, may be obtained from the Publications Section, Federal Power Commission, Washington 25, D. C. The price is $5.00 per copy. The order number is FPC S-98. A 25-page summary of the report, priced at 25 cents per copy, also is available.

FIG. 2.

Smooth Bending of 36-in. Pipe Now Possible

When these larger diameter lines become a reality, one obstacle to their construction will have been removed

DON FOSTER*

THE rapidly growing popularity of natural gas as a fuel is resulting in greater consideration being given to the most economical means of transporting the higher capacities through a pipe line. Whether additional lines up to 30-in. diameter or fewer lines of the larger 36-in. diameter size will be more desirable is still unknown as many factors have to be considered.

*Chief Engineer, Crutcher-Rolfs-Cummings, Inc.

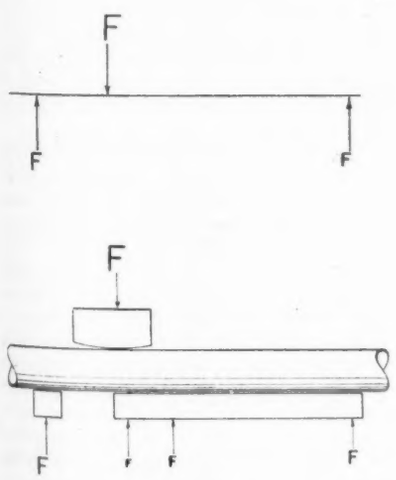


FIG. 1.

Although, for numerous reasons in the past, 30-in. pipe has been the maximum, except in a few special cases, this article will be limited to a practical approach to the problem of smooth[1] cold bending of 36-in. pipe by Crutcher-Rolfs-Cummings, Inc., in cooperation with Transcontinental Gas Company of Houston, Texas.

The afternoon of August 29, 1952, saw the first successful practical smooth cold bending demonstration ever to be made on 36-in. pipe. The necessity of constructing a portable bender that could be transported on highways, could travel down the pipe line right-of-way, and could still bend thin wall pipe, as well as heavy wall pipe, to fit any normal ditch profile, appreciably increased the problems.

Modern bending, which still relies on the age old principle of the simple lever, requires the bending moment applied to exceed that moment capable of being resisted by the pipe without taking a permanent set.

This basic principle combined with a few finer features made up the portable pipe bender used in this test. (See Fig. 1.)

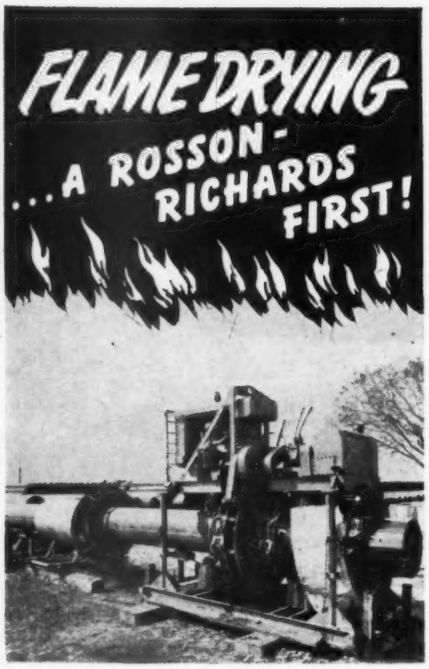
[1]Smooth to differentiate from wrinkle, which allows a controlled wave of about 4 in. wide to form on the outside of the pipe.

EXCLUSIVE

The most serious bending problem encountered, is to maintain wave-free bends and round cross-sections of the pipe in the bent area. The power to bend even the heaviest walls and diameters is available by simple increases of mechanical advantage through properly designed frames. How strong is the sample of pipe such as that bent in the test described? The calculated strength of the pipe is equivalent to 7-10-in. 49-lb wide flange beams. The ability to make smooth bends depends upon the diameter of the pipe, the hardness, wall thickness[2], the uniformity of the hardness and wall thickness, and to a very large extent, the surface smoothness of the bending shoe. Irregularities of a small fraction of an inch in the bending shoe become extremely serious in the prevention of waves in the upset inside wall of the bent pipe.

It was not practical for a 2500-lb steel bending shoe, as cast, to have the necessary surface smoothness to enable a most proficient operator to bend the 36-in. diameter pipe properly, therefore, some means of machining the shoe had to be devised. There was nothing available that could machine a casting with the bending shoe physical dimensions

[2]A comparison of the 0.395-in. wall thickness of the 36-in. pipe to a proportional of 0.0329-in. for 3-in. pipe will give an idea of the great ratio of diameter to wall thickness of the pipe that was actually bent.



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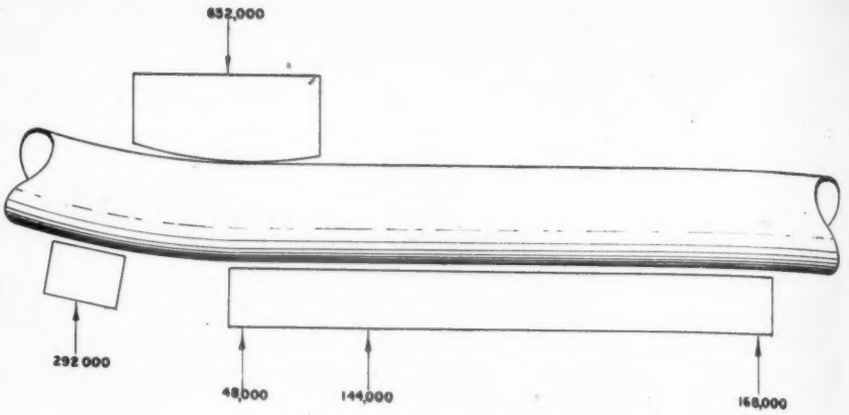

FIG. 3.

Position of Sample in Bend	Thickness	Yield	Ultimate Strength
Unbent Pipe	0.390	58,400	82,000
Inside of Bend	0.402	61,900	82,800
Right Side of Bend	0.398	56,500	81,600
Outside of Bend	0.387	74,300	85,800
Left Side of Bend	0.398	60,000	82,700

FIG. 4.

(24-in. deep by 40-in. wide by 60-in. long with a radius of curvature 52½ ft). This brought about the construction of a shoe borer similar to a horizontal boring machine with curved ways, which did a satisfactory job even though it did not approach most machine tool accuracy.

The other principal parts of the bender were fabricated from steel plates and structural shapes as can be seen in the accompanying photograph (Fig. 2).

Power for the bending process was obtained by the use of a Tulsa "80" winch driven by an International U-6 engine with transmission. The principal bending force was produced by four, 4-sheave, wire rope, needle bearing blocks at the front of the bender. One common cable threaded through the blocks at the front of the machine and additional blocks at the middle of the frame produced the necessary bending power and squeeze adjacent to the bending shoe to aid in the bending operation and to force the pipe to maintain its round cross-section even during the actual bending process. Greater bends can be made in a joint of pipe by allowing the pipe to flatten in the bent area, but because maximum roundness is desirable to facilitate inside cleaning, welding, and obtain satisfactory flow conditions, this feature was given a great deal of consideration. In actual test the diameters in the bent section were within the limits of normal pipe diameter plus or minus ½ in.

The actual measured and calculated forces at the middle of the bending operation may be seen by considering the accompanying diagram of the pipe and shoe. (Fig. 3.)

The forces on the holding shoe and the bending shoe would be increased by approximately 70 per cent in the early part of a bend in ½-in. wall pipe. This establishes the approximate maximum working loads for the frame.

Laboratory tests on the unbent pipe showed a yield strength of 59,200 psi and an ultimate strength of 88,800 psi. These values clearly place the samples tested in the higher ranges of hardness for line pipe. Fig. 4 gives the physical characteristics of the steel in the unbent portion of the pipe, as well as in four positions in the pipe where a bend of ½ plus degree per lineal foot of pipe actually existed.

Fig. 4 also shows that in the bending process only a slight increase in yield strength occurs where the steel has been cold worked. Variations in wall thickness, which might be expected, are barely apparent and certainly are well below mill tolerance on the original plate from which the pipe was made.

Large diameter thin wall pipe such as this can be bent satisfactorily though the shortness of the bend will not necessarily be as great as in smaller pipe. One more obstacle in the road to planning and constructing even larger diameter pipe lines, than is now customary, has been removed. ★ ★ ★

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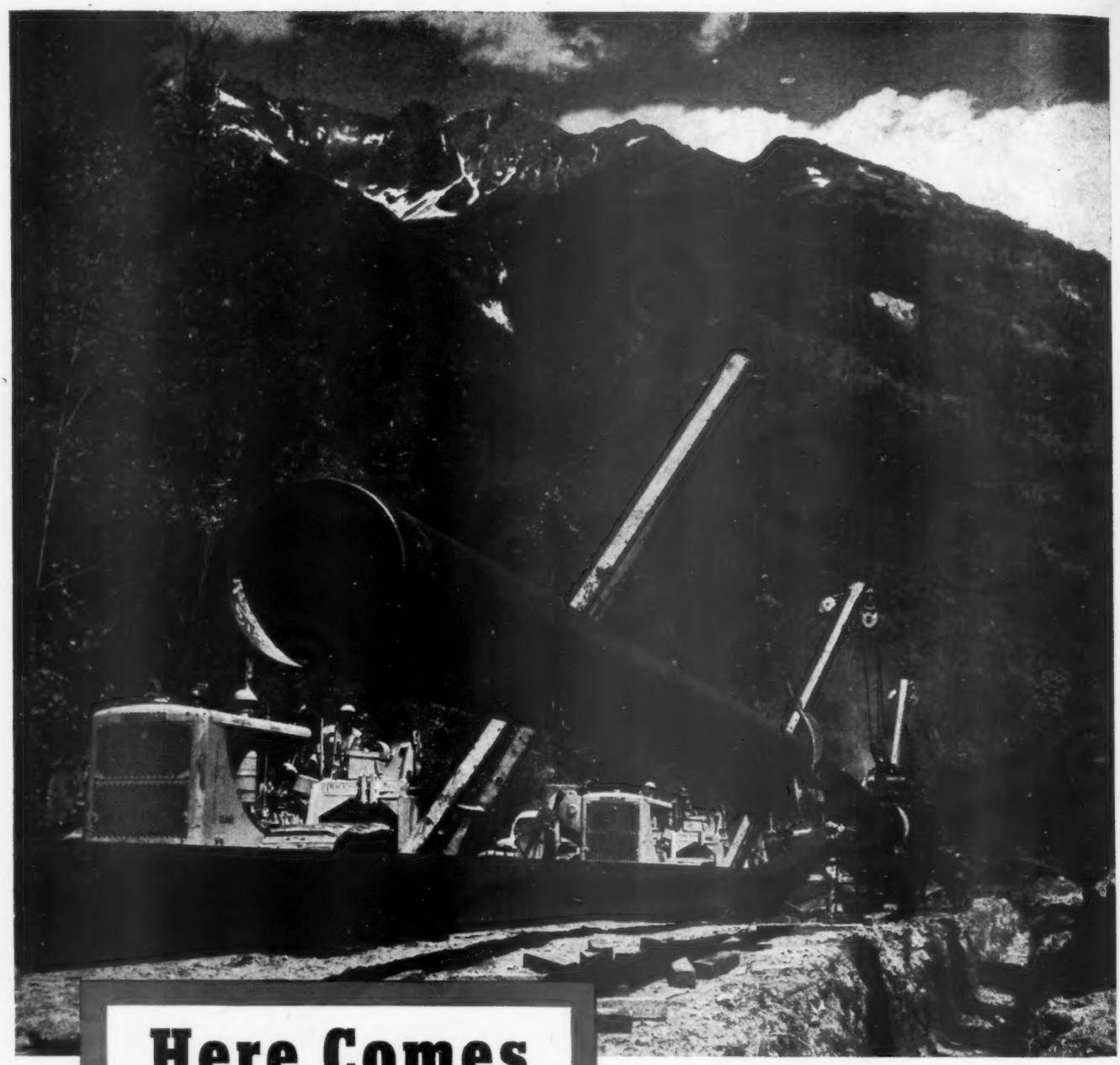

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DEVELOPING ORGANIZATION HARMONY*

Proper attitudes and actions of top management are key factors in developing employee morale and harmony in organization

H. H. ANDERSON†

An organization is akin to a living organism. Most every manager must draw organization charts. Some of these on paper, have the spreading grace of Sally Rand's fans; but whether or not the organisms they cover are as harmonious as Sally's, is a matter to be scrutinized.

"Organization," the verb transitive, is the formation of interdependent parts into a whole for united action to achieve the goals of an interprise. The development of such unity of purpose requires not only the proper division of activities among the parts, but also the creation of an atmosphere in which they will function harmoniously.

Our pipe line companies are not peculiar organisms, but pipe line systems operate under peculiar conditions, which create peculiar problems. The first of these conditions, especially with the newer "closed" systems, is the complete interdependence of all physical facilities in supplying service. A second condition is the isolation of these facilities, and of the groups of employees who maintain and operate them, along narrow rights-of-way often hundreds of miles long.

Interruptions of our pipe line service are usually expensive. The customers are discommoded, and the throughputs and revenues lost by our owners are often irretrievable. On some of the large-diameter longer lines, these revenue losses can run as high as two to four thousand dollars per hour, and they can be caused by any one of a thousand things attributable to employee errors, as well as facility breakdowns.

Our peculiar locales of operation compound the felony. Most of our rights-of-way property is owned by private persons or the public whose occupancy and traverse can injure the facilities. Many of our most serious shutdowns and revenue losses are thus caused, and these often involve accidents that endanger limb and life, as well as property.

Errors by employees can be lessened in frequency through training in correct work procedures. Harmful acts of property owners or the public can be lessened through training employees in good public relations. The duration and effects of interruptions can be reduced through training employees how promptly to meet and handle the various types of emergencies created.

Such training is of little value, however, unless our employees are impelled by a deep sense of loyalty and responsibility to apply it at all times. In a pipe line company the development of this spirit requires the integration of the many isolated groups of employees into a single, loyal, and responsible unit. I am convinced that with us the development of loyalty and high morale is as important as the development of "know-how." This, in fact, is our basic problem of pipe line organization.

What is this loyalty we seek of the employees? It is their appreciation of their company obligations, as well as their rights and privileges. It is their desire to stick on the job—to work harmoniously, vigorously, and carefully, and to carry the tongue of good report to the public. Loyalty, in essence, is the recognition by the employees of their common interest with the employer. The loyalty and morale of the rank-and-file of an organization generally reflect those of its upper echelons.

Proper attitudes and actions of top management are the key factors in developing employee morale and organization harmony. To summarize these:

Attitudes. Recognize that the production, service continuity, and income of your business can be held at a high level only when your employees wholeheartedly give you their best effort. Remember always that the employees are fellow-humans entitled to fair and considerate treatment, and that they desire mental and social, as well as financial, satisfaction from their work.

Actions. Use every available channel to keep honestly apprised of your employees' attitudes and problems. Adopt policies aimed to satisfy their reasonable desires, as well as their basic needs. Assure that these fair policies are known to all concerned, and are equitably administered at all levels of supervision.

As a working guide to this end, I offer my own personal philosophy or code as follows:

1. Heed the desire of the employees for interesting work, credit for work well done, understanding and appreciation of their problems, and personal counsel.

2. Cultivate and extend direct contacts of top management with the rank-and-file, and use every devisable channel to maintain unbiased two-way communication between them.

3. Develop a sound program of employment conditions. Maintain equitable opportunities for development, training, and advancement. Especially arrange for a prompt and considerate settlement of grievances. Administer these fundamental rights scrupulously.

4. Clearly set forth in writing, and by a handbook where there is no union contract the company's employment conditions and other personnel policies. This insures that all supervisors gain a common understanding of the "bill of rights" guaranteed by top management to the employees who also are made aware of their privileges and obligations.

5. Keep well informed of competitive wage and benefit conditions, and make proper revisions before any justified worker dissatisfaction can develop. Be especially alert to changes in job duties and proper job-rate differentials.

6. Handle formal personnel relations with employees through the "line" organization. Let the staff specialists remain in the background and train the superintendents and foremen to do the job. This improves the morale of the supervisors and their effectiveness in work direction.

7. Believe that foremen training is an essential, not a fad, and keep it active. To most rank-and-file employees the foremen represent the management and its attitudes. A wise management will train them to be effective ambassadors.

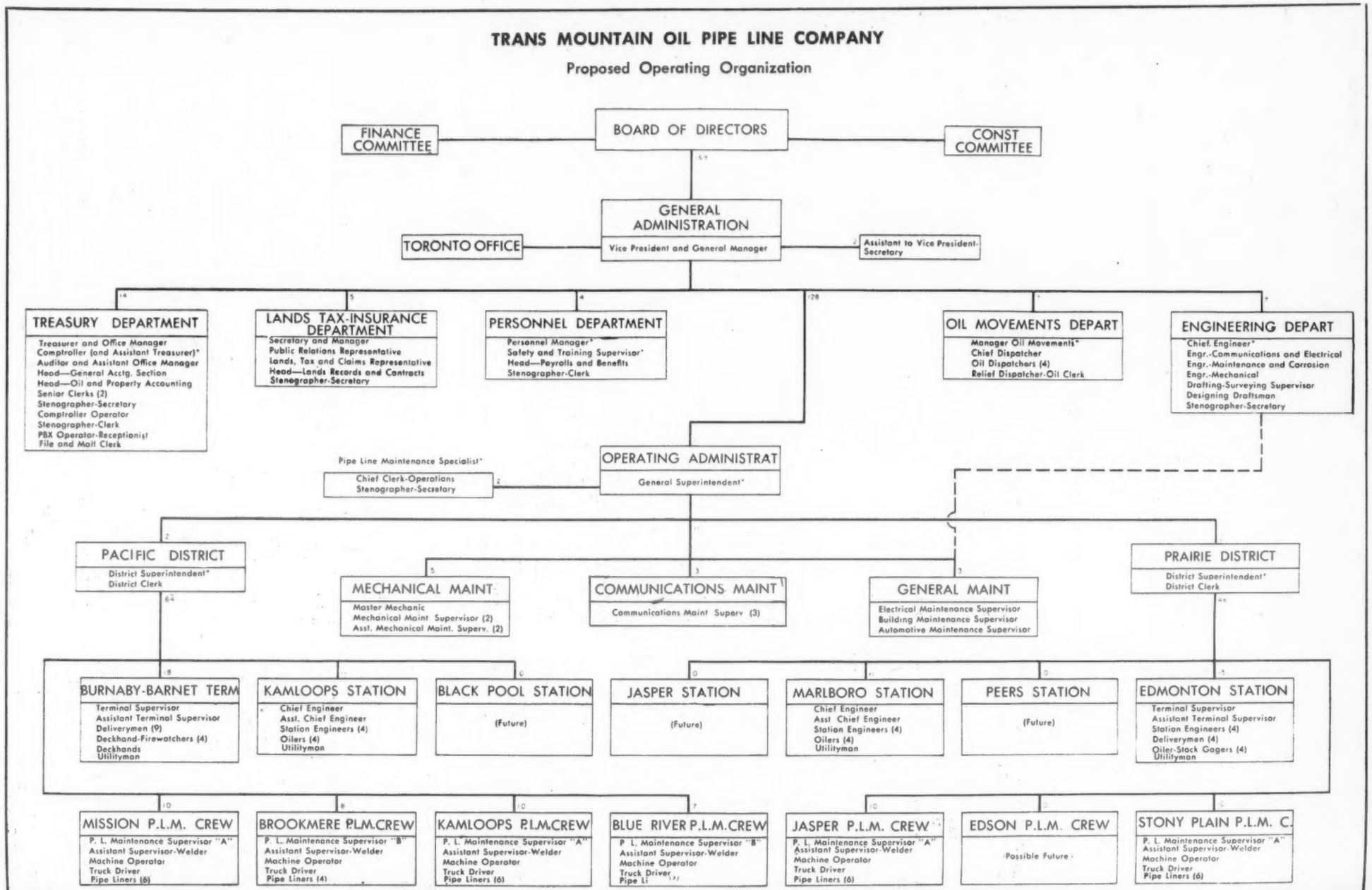
8. If in trouble with organized labor, remember that the employees are acting within their rights, and that management must adapt itself to the situation if it hopes to keep employee morale and work out-turn at an acceptable level.

9. Keep faith in the organized rank-and-file employees, and preserve their faith in management. Don't antagonize the employees if they seem to be misled. Remember that the success of the business depends on their good will. Don't deny them benefits merely to discredit their leaders, because such strategy will boomerang.

10. In a partly organized establishment, be strictly impartial when dealing with various employee groups. Don't let the squeaking door get all the oil! Stand pat on denying to some employees privi-

*Presented before American Petroleum Institute, Division of Transportation, Chicago, Illinois, November 11, 1952.

†Vice president and general manager, Trans Mountain Oil Pipe Line Company, Vancouver, British Columbia, Canada.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Comptroller (and Assistant Treasurer)*
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Head—General Acctg. Section
Head—Oil and Property Accounting
Senior Clerks (2)
Stenographer-Secretary
Comptroller Operator
Stenographer-Clerk
PBX Operator-Receptionist
File and Mail Clerk
LANDS TAX-INSURANCE DEPARTMENT
Secretary and Manager
Public Relations Representative
Lands, Tax and Claims Representative
Head—Lands Records and Contracts
Stenographer-Secretary
PERSONNEL DEPARTMENT
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Safety and Training Supervisor*
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OIL MOVEMENTS DEPART
Manager Oil Movements*
Chief Dispatcher
Oil Dispatchers (4)
Relief Dispatcher-Oil Clerk
ENGINEERING DEPART
Chief Engineer*
Engr.-Communications and Electrical
Engr.-Maintenance and Corrosion
Engr.-Mechanical
Drafting-Surveying Supervisor
Designing Draftsman
Stenographer-Secretary
Pipe Line Maintenance Specialist*
Chief Clerk-Operations Stenographer-Secretary
OPERATING ADMINISTRAT
General Superintendent*
PACIFIC DISTRICT
District Superintendent*
District Clerk
MECHANICAL MAINT
Master Mechanic
Mechanical Maint. Supervisor (2)
Asst. Mechanical Maint. Superv. (2)
COMMUNICATIONS MAINT
Communications Maint. Superv (3)
GENERAL MAINT
Electrical Maintenance Supervisor
Building Maintenance Supervisor
Automotive Maintenance Supervisor
PRAIRIE DISTRICT
District Superintendent*
District Clerk
BURNABY-BARNET TERM
Terminal Supervisor
Assistant Terminal Supervisor
Deliverymen (9)
Deckhand-Firewatchers (4)
Deckhands
Utilityman
KAMLOOPS STATION
Chief Engineer
Asst. Chief Engineer
Station Engineers (4)
Oilers (4)
Utilityman
BLACK POOL STATION
(Future)
JASPER STATION
(Future)
MARLBORO STATION
Chief Engineer
Asst Chief Engineer
Station Engineers (4)
Oilers (4)
Utilityman
PEERS STATION
(Future)
EDMONTON STATION
Terminal Supervisor
Assistant Terminal Supervisor
Station Engineers (4)
Deliverymen (4)
Oiler-Stock Gagers (4)
Utilityman
MISSION P.L.M. CREW
P. L. Maintenance Supervisor "A"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
Pipe Liners (6)
BROOKMERE P.L.M.CREW
P. L. Maintenance Supervisor "B"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
Pipe Liners (4)
KAMLOOPS P.L.M.CREW
P. L. Maintenance Supervisor "A"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
Pipe Liners (6)
BLUE RIVER P.L.M.CREW
P. L. Maintenance Supervisor "B"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
JASPER P.L.M. CREW
P. L. Maintenance Supervisor "A"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
Pipe Liners (6)
EDSON P.L.M. CREW
Possible Future
STONY PLAIN P.L.M. C.
P. L. Maintenance Supervisor "A"
Assistant Supervisor-Welder
Machine Operator
Truck Driver
Pipe Liners (6)
*During period of training and early operation, these positions will be occupied also by temporary specialists.

leges that are not warranted for all, and extend immediately to all any concessions forced by a few.

11. Organized labor seeks to insure through contract the individual's rights to work, to receive fair treatment, to enjoy equitable promotion opportunities, and to appeal his grievances. Obviously, then, the quicker management voluntarily provides these sought conditions —and who can deny that they are humane and fair—the less likely are the employees to organize militantly, if at all, and the more likely is management to profit from an inevitable liberalization.

The evils of unionism usually stem from the collective power it gives to carpet-baggers and local demagogues who have been aided and abetted for 20 years by bureaucrats who preach that success in any business but theirs is a sin. A recent new employee said to me: "The main thing I didn't like about my old union was that the business agent was always trying to convince us that our company is a so-and-so, and he quoted our great 'whistle-stopper' to prove it!"

There are waves of malicious propaganda at every turn trying to destroy our precious employee loyalty and business harmony. Thus it is not enough for us to treat our employees fairly and to maintain working conditions such that the company and the employees can progress together. No, indeed! Today we are forced to conduct a deliberate campaign of counter-propaganda to keep our employees aware of the fact. We can only hope that the election results last November prove that the tide has been stemmed, if not turned.

You may have observed that my remarks about the attitudes and actions necessary for good employee relations apply to most industry, and are not unique to our pipe line business. The principal differences in the pipe line business are the mechanics of their application most effective for integrating our isolated groups of employees into a single, loyal, and responsible unit.

As I said at the outset, to accomplish this, we must first establish proper work divisions and procedures, and then we must create an atmosphere in which they will function harmoniously. The one is perhaps a matter of charts and manuals, but the second is a matter of personalities and human relations.

These two aspects of the problem are inseparable. For example, when duties, responsibilities, and authorities are assigned, we must always give heed to attributes, abilities, education, and experience. I read recently: "Don't mistake an organization chart for an organization. After all, it's the people who go into the jobs, and how they get along together, that make it work or fail." Thus —at least for the more senior staff—the setting up of our charts and manuals must take due account of their personalities. But, in every case, sound principles of work division must be conformed to, or we shall be defeated in our purpose.

A sound principle of organization is one that always contributes to its harmony. As between the staff department heads, perhaps the most important principle is to minimize work overlap or duplication. Another one is to divide or aggregate their activities as far as practicable with respect to allied functions. Such functional aggregations in a typical pipe line company may be general administration, finances, corporate affairs, engineering, materials, personnel, oil scheduling and dispatching, and physical operation and maintenance.

To divide and assign the activities most logically, some clarity of analysis is needed. To illustrate my point, let us consider the work allied in personnel relations. Payroll preparation, for example, involves finances; yet primarily it concerns the employees. Thus it should be most effectively carried on in the personnel department under the watchful eyes of those best acquainted with the applications of wage scales, benefit plans, labor regulations, workmen's contracts, and other factors pertinent in payroll makeup. On this same premise it is better to place the handling of workmen's compensation insurance and safety promotion in the personnel department than to place these, respectively, in the legal and engineering departments.

For most harmonious functioning, the division and assignment of activities between the head office staff and the "line" or field departments require even more careful analysis. The accepted functions of the staff are to plan, guide, and render service, whereas that of the "line" is to execute the plans. Yet the views of the "line" must be solicited and duly considered whenever any plans of consequence are being made. This not only prevents mistakes, but also it promotes harmony and cooperation.

In such planning, too, the head office general administrator must concern himself with correlation of the staff departments as well as that of staff and "line." Otherwise there can develop a conflict of staff planning objectives that will cause confusion in their execution by the field.

Many plans are formulated as rules of procedure. The intention as well as the modus operandi of such rules should be made clear, so that ambiguity of purpose is removed. Then the staff will have the least excuse to irritate the "line" by policing the interpretations and applications of such rules in the field. Also, the staff will then have more time with which to deal with other planning.

The same principles should govern the more detailed plans and specific interpretations made in the field offices for guidance of the front-line supervisors. Those concerned should remember that nobody has a corner on brains, and that loyal and responsible foremen will never be developed if their opportunities for individual thinking are reduced to those of automatons.

The assignment of work among the field office-staff employees should generally reflect that of head office, although consolidations are proper when the required number of such employees is small. Numerous contacts between counterpart head-office and field-office staff employees are necessary in the daily routine. If such contacts are permitted and encouraged at the lowest rank consistent with policy control, loyalty and responsibility among the office rank-and-file are developed.

The same holds true as to routine contacts between different departments and divisions within the head office. The cutting of red tape in all such contacts and their handling at junior levels will save a great waste of time, and will greatly improve employee morale. This handling may seem at variance with the organization chart, but it is said that the integration of department heads with one another and the personal development of their subordinates are best encouraged informally rather than by a formal structure.

A pain in the neck of everyone else is the narrow-minded chief who must straddle everything, even requiring the simplest contact to be made in his name. Most juniors can be trusted to use good sense in their job routines when they deal directly with other sections, departments, or divisions, and to refer policy questions to their chief.

Not mentioned yet in this discussion are those staff specialists or representatives who must move about the field on liaison and who directly handle service department work. I refer to such employees as tax and claims men, safety and training representatives, valuation and corrosion engineers, gaging inspectors, auditors — yes, even editors — and the like. Some of these may work out of the head office, and others out of field headquarters. Perhaps no other group can be so effective to build organization harmony or to destroy it.

It has been my lot to address convention meetings of several types of such specialists, and my fortune—good or bad—to sit in on their cocktail-hour bull sessions. I regret that many of them there have let down their hair and commiserated with one another that their boss fails to give them the attention, support, and encouragement needed to do their tough jobs well. That's why they seek every possible chance to meet and discuss their common problems, and to get a recharge of morale.

Yet here is a key group whose own morale—whether in the clouds or in a slump—is spread among, and reflected by, the field employees. This is something every manager should recognize. Their contacts afford invaluable oppor-

Formation of Canadian Region Weighed by NACE

A petition signed by 81 Canadian members of the National Association of Corrision Engineers asking that the association establish a regional subdivision in the Dominion has been sent to the NACE board of directors. The association has more than 4000 members.

Two petitions for new sections of NACE have been received also. They originated at San Diego, California, and at Jacksonville, Florida.

*During period of training and early operation, these positions will be occupied also by temporary specialists.

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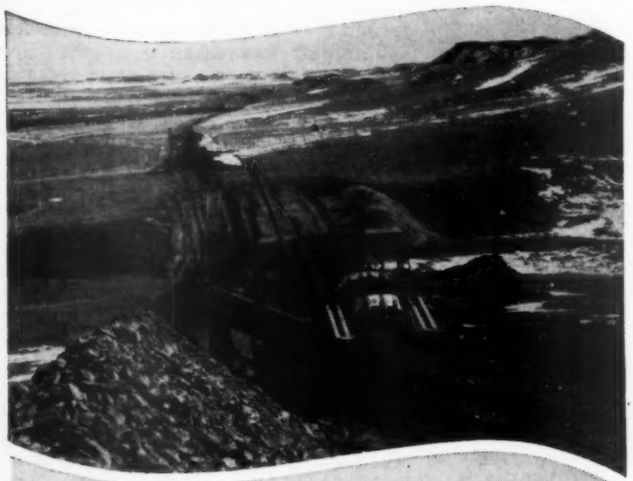

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tunities to build good will by selling the company and the management to the rank-and-file. But they are poorly equipped to make this contribution to organization harmony unless their own morale is kept at a high level through sympathetic handling by their boss.

The personnel-relations men, the safety and training men, and the house organ editor are especially important in keeping the employees sold on their jobs and their company. These staff specialists have been selected because they are supposed to know how to do that well. They can do a lot themselves; but, unless the boss himself and the operating heads have a keen personal interest in the doing of a job which serves their own personal responsibility, the result at best will be mediocre.

Next we come to the foremen, who are the front line of management. In them are focused for execution, at the job level, the plans for many specialized objectives, viz., high job productivity, steady work out-turn, effective maintenance, prevention of waste, low unit costs, daily reports of all kinds, safety, and industrial relations.

Few businesses are as dependent as pipe lines on their front-line supervisors. I refer to our station chiefs, our gaging chiefs, our maintenance foremen, and the like. They are the key men among our isolated crews who are most responsible for keeping our interdependent facilities in operation, and to handle the emergencies created by service interruptions. These emergencies may require them to cope promptly, intelligently, and fearlessly with serious accident hazards.

Foremen also carry the brunt of management's responsibility to create loyalty and harmony among the rank-and-file. Obviously, then, the development of their own loyalty is most important. Thus top management should see that the foremen are well satisfied with their own salaries and treatment, if good will is to be projected to the front line of management contact.

Foremen must be given help in developing team work and in eliminating personal worry on the job. In this they can make headway only if the general wage structures, benefit plans, and grievance procedures are fair and understood by all of their administrative supervisors, as well as by the workers. When the workers feel that they are getting a square deal from the company and the foremen, the foremen usually can get them to give the company and their fellow-workers a square deal and cooperation in return.

It is obvious that every member of a pipe line organization must do his or her part if it is to be integrated into a loyal and responsible service unit. But who will deny that the manager is the hub of the whole process? He, above all others, must show consideration and fairness; and he must do this wisely, sincerely, and continuously. From him must radiate the good will essential for success. The manager, indeed, must draw his fan-like charts, but also he is responsible for the harmony of the organism beneath the fan. * * *

PIPE LINE PROGRESS

26-inch for Texas Gas Transmission Line

It was in 1950 that Texas Gas Transmission Corporation completed construction of a new, large-diameter natural gas transmission system. It transports gas from Louisiana and Texas reserves to customers in Arkansas, Mississippi, Tennessee, Kentucky, Indiana, Illinois and Ohio.

Additional pipe was lowered in during 1951 to provide increased capacity through looping and extension, lines that will be completed in 1952. These will increase natural gas deliveries to Texas Gas Transmission customers in all these states.

A. O. Smith's contribution to this great addition to the major gas transmission systems of the nation has been shipment of more than 1,300 miles of 26-inch, 20-inch and 16-inch diameter pipe. They were delivered to meet construction requirements for the main line, looping, extensions and some river crossings.

Our welded steel line pipe, internally expanded and accurately sized, constitute a large part of the petroleum and gas transmission lines on this continent. Through the years, A. O. Smith capacity has met the challenge of rapidly expanding pipeline systems that now crisscross America.

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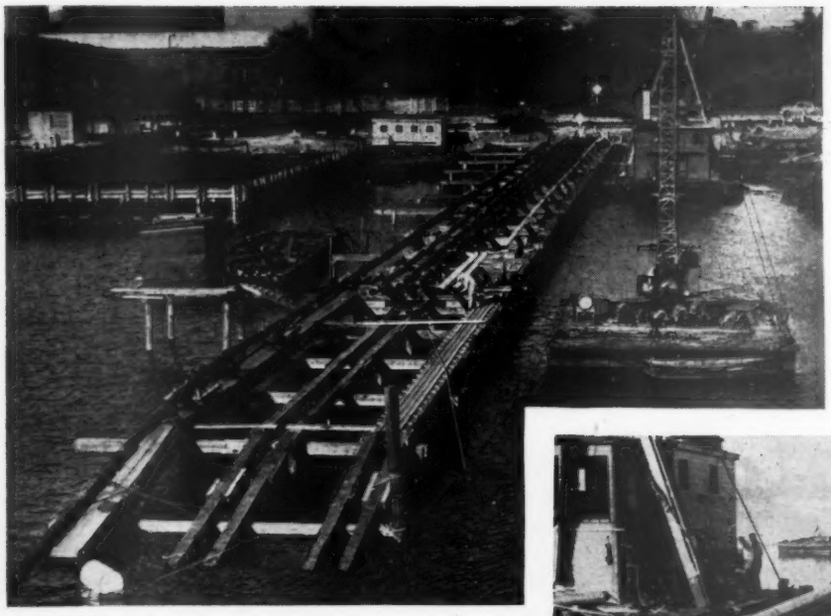
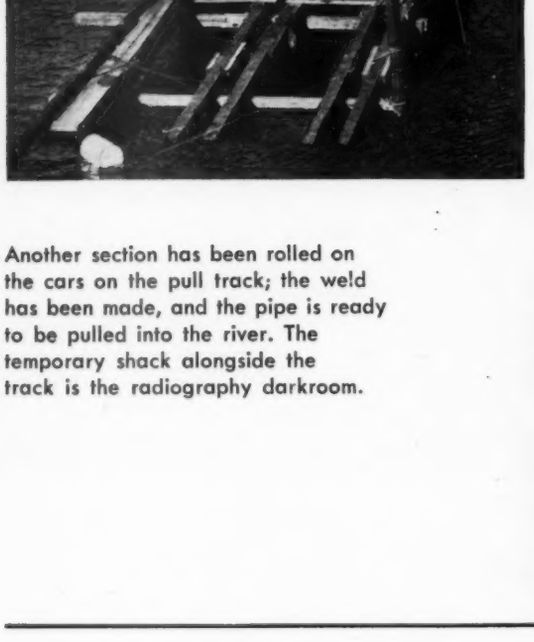
P. 623.91

PHOTOS BY W. L. GRIFFIN



Pipe being prepared for installation. Note the stages of preparation: Coated and wrapped pipe; next rock shield applied; then river clamps, and finally rolled on the cars on track for the pulling operation.



Another section has been rolled on the cars on the pull track; the weld has been made, and the pipe is ready to be pulled into the river. The temporary shack alongside the track is the radiography darkroom.

Crossing the Providence River

Procedure used to make 2560-ft crossing at depth of 52 ft

H. H. JOHNSON and W. L. GRIFFIN

In a trench, 52 ft below the surface of the Providence River bed, three 10¾-in. OD pipe lines spaced 10 ft apart were recently laid between the Gulf Oil Company property in East Providence to the Providence Gas Company plant in Providence, Rhode Island — a distance of 2560 ft.

The project was under the supervision of Ford, Bacon and Davis, Inc. The contractor, Merritt, Chapman and Scott Corporation, veterans of marine work, made arrangements with Great Lakes Dredge and Dock Company to perform the dredging, the major part of which was done by the dredge "Crest," declared by its captain to be the biggest dipper dredge in the world. Digging steadily, with the employ of three 8-hr shifts, the dredging was completed in 12 days.

After the pipe was protected with 3/32-in. of enamel and a healthy application of wrapper and rock shield, river clamps weighing 800 lb each were installed 20 ft apart. Due to a railroad siding being near the shore, all preparatory work had to be done on falsework.

EXCLUSIVE

A pulling operation began with a continuous section of pipe, approximately 400 ft long, rolled on the track cars. Two winches, powered with 400-hp motors, situated on the opposite shore, were used to pull the pipe. When a car was pulled to a point near the end of the ramp, a floating crane hooked to the car to retrieve it after it was submerged free of the pipe. When the section had been partially pulled into the water, another section of pipe was rolled on the track cars, the adjoining weld was made and X-rayed, and the pull operation was ready to commence. ★ ★ ★

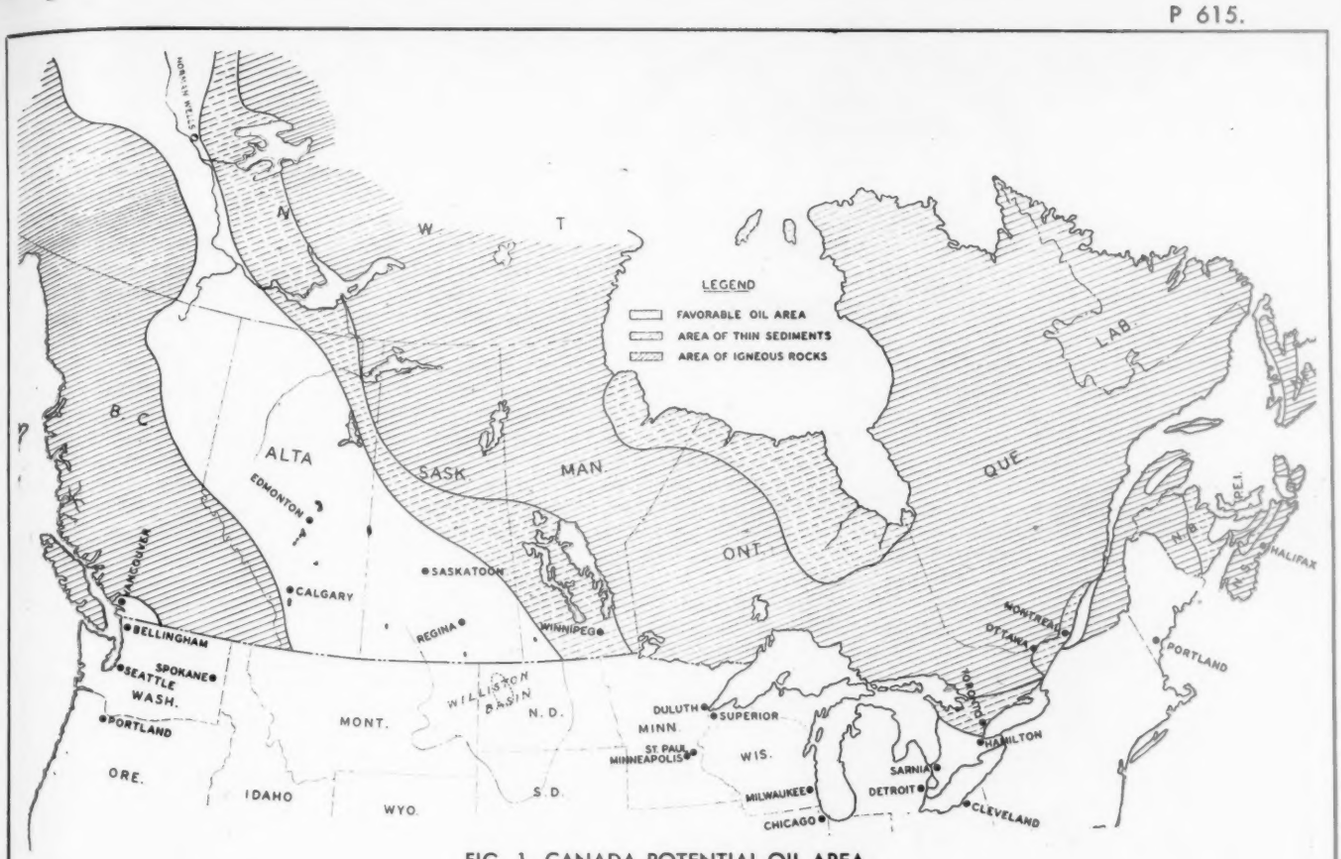


FIG. 1. CANADA POTENTIAL OIL AREA.

Canadian

Oil Production and Transportation*

S. M. BLAIR† and IAN G. WAHN‡

BEFORE we examine Canada's present oil production and transportation, it is desirable — and indeed necessary — to look first at the early history of our crude oil developments in order to understand fully the Canadian position.

In the 1850's, 100 years ago, crude oil production began on a major scale from wells in southwestern Ontario. The oil was of a good quality, and the wells were very productive even against today's standards. Gushers flowed uncontrolled, releasing large amounts of oil into the neighboring rivers and lakes. At that time practically nothing was known of underground conditions, nor of any means of transporting the crude oil other than by horse-drawn vehicles.

Unfortunately adequate reserves did not exist to sustain the production. Before the close of the century Canada had ceased to export, and her own demand for oil products overtook her production. That early experience, however, left an indelible mark on the oil history of Canada.

We are proud of those early oil pioneers. It was unfortunate that the producing structure that they found, at the southern tip of a great rock shield, was so limited in area. They succeeded, however, in making some very worthwhile progress. While working with the oil development, they proved up an appreciable gas field, and an oil industry was begun in the Sarnia district, which has grown into a leading Canadian oil refining and chemical center. A surprising number of drillers was trained in that field, and developed there a drilling technique that was successfully used in oil fields throughout the world. More important still, they and their descendants created an oil consciousness in Canada, which persisted through all the barren years, and which was a very material factor in getting suitable financing, oil legislation, and controls quickly into operation when large reserves of oil were finally found.

What a difference in the technique and know-how that was available for Canada's new fields when compared with that available for the original discoveries. A system of modern refineries capable of supplying the nation's total requirements was ready to process the new oil.

In the field of transportation, the industry has developed a system that permits a tariff from the Canadian prairies

*Presented before the American Petroleum Institute, Division of Transportation, Chicago, Illinois, November 11, 1952.

†Vice president, Trans Mountain Oil Pipe Line Company; vice president, Canadian Bechtel, Ltd.

‡Secretary, Trans Mountain Oil Pipe Line Company.

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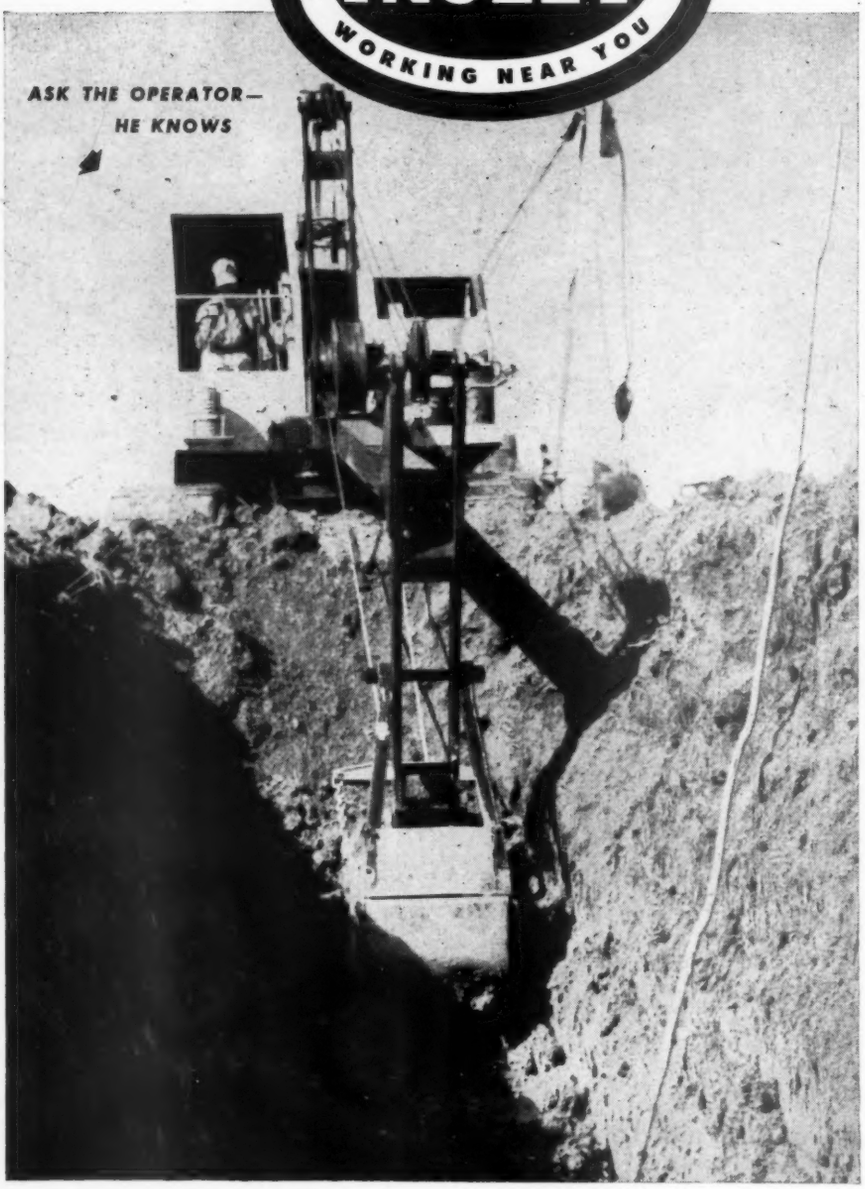
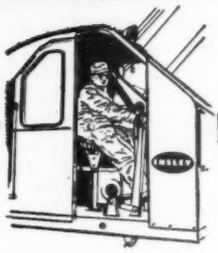


The INSLEY operator



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to the Pacific Coast, or to the Great Lakes, equal to the charge made in 1850 for moving crude oil out of the bush in southwest Ontario to St. Clair River.

After reviewing our early oil history, we can see more clearly the reason for the prevailing attitude of the public and the government toward development when new fields were discovered in 1947.

Canada's Oil Resources

The presence of a vast sedimentary basin in western Canada, in which geological conditions were favorable for the accumulation of oil, was known for many years. Yet the only actual formation with recoverable oil found in that area was discovered early in this century in the Turner Valley. That discovery helped sustain the search for oil through the west in arid years when millions were being spent with little to show other than dry holes.

The part of western Canada shown in Fig. 1, which is favorable to the accumulation of oil, covers an area equal to about 15 per cent of the whole country. The area falls across the southwest corner of the province of Manitoba; covers about 40 per cent of the province of Saskatchewan (including the northern part of the Williston Basin area, which is attracting particular attention at present); and continues across the greater part (80 per cent) of Alberta and the northeastern corner of British Columbia. It then extends away through the Northwest Territories for almost 1000 miles to the Arctic Coast. It will be remembered that near the Arctic Circle, at Fort Norman, a successful oil field has been proved along the Mackenzie River some 400 miles from its mouth.

Lying right in the midst of that great potential oil country is the bulk of the province of Alberta, an area of a little over one-quarter of a million square miles, i.e., just slightly larger than France. Alberta contains practically all of the now proved oil fields. Its proved gas fields are acknowledged to be in the order of 8 to 10 trillion cubic feet, and in addition it contains the famous Athabasca oil sands, which, lying along the Athabasca River, cover many thousands of acres and in themselves represent a vast potential oil production.

In addition to the developments in Alberta, oil exploration work is being vigorously pursued and in the neighboring province of British Columbia on the west and Saskatchewan and Manitoba on the east. About 95 per cent of Canada's total production comes from Alberta; and, due to that province's early start, it has taken the lead in developing oil legislation and practices. The disposition of government-owned petroleum and natural gas rights is similar in all the provinces, and for that reason the present review will be based on the Alberta policies. The latter province occupies a central position within the potential oil-bearing area; and it, therefore, appears that the locations of pipe lines carrying oil from Alberta to the major markets will also be suitable to service the whole area.

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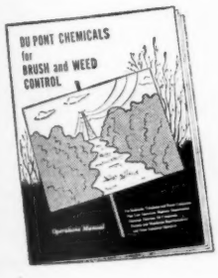

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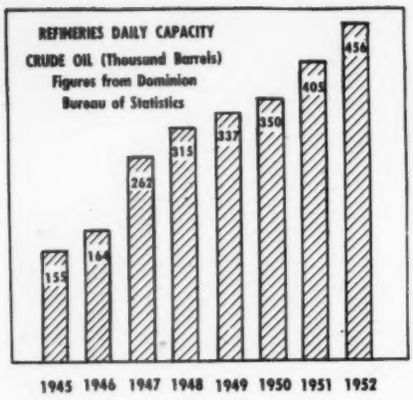

FIG. 2.

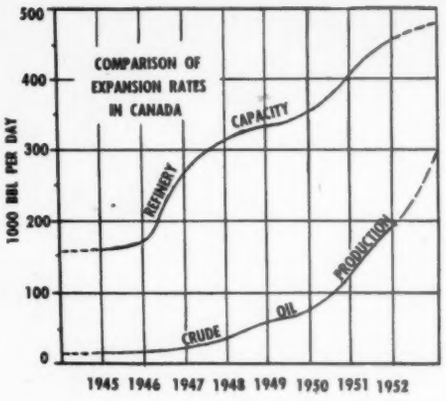

FIG. 3.

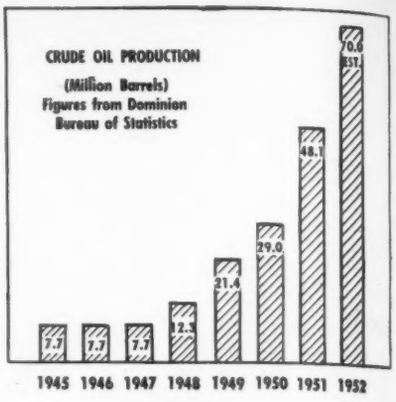

FIG. 4.

rights are privately owned; 10 per cent are federally owned, and the remaining 80 per cent are owned by the province.

It is now estimated that the available oil production by mid-1953 will be 300,000 bbl per day. Of this total, it is estimated that about 35 per cent will be of the general Redwater quality; 50 per cent of the Leduc-Wizard Lake types, and the balance will be oils varying from the very light Turner Valley product to a number of intermediate crudes, and a limited amount of heavy oil from the Lloydminster field.

Data pertinent to crude oil production are given in Figs. 2, 3, and 4 compiled from the latest published government and industry records.

TABLE 1. Principal Western Canada crude oils inspection data.

	Wizard Lake and Leduc	Redwater	Stettler	Turner Valley	Big Valley	Flint	Golden Spike	Lloydminster
Gravity, deg API	39.2	34.9	27.7	42.7	33.2	35.9	35.3	14.5
Sulfur, per cent	0.34	0.48	1.55	0.39	0.99	0.94	0.23	3.14
Pour point, F	25 to 20	—50	5	—30	+30	—15	0 to —5	15 to 10
Water and sediment, per cent	0.20	Trace	1.6	0.50	1.0	0.5	0.5	1.6
Initial boiling point, F	132	111	119	98	120	120	118	207
Per cent over at 400 F	40	35	27	47	30	36	36	8.0

Alberta's Transportation

Excluding the Turner Valley and Lloydminster production and the new discoveries in the northwestern part of the province, gathering and transport systems are available, or approaching completion, which lead to Edmonton, as shown in Fig. 3. The sizes of lines, etc., are noted in Fig. 5.

Large bulk storage has been provided by both Trans Mountain and Interprovincial at their adjacent terminals in South Edmonton.

Oil Refineries

While the oil exploration departments were going through such trying experiences for several decades in Canada, other divisions, such as refining, were steadily advancing. Thus, by the beginning of

Shown at the left is a Console Control Desk which is one of several being built by us for service in the pumping stations of a major pipe line company.

This desk provides automatic sequence control of valves and pumps when used in conjunction with high and low voltage motor control equipment.

Appearing on the top of the console is a diagram of the piping layout of the station which gives a visual picture of operations by means of indicating lights. These lights also reveal many abnormal conditions such as high bearing temperatures, low suction or high discharge pressures and motor overloads. The surface of the desk top is flat except for the projection of the push button stations, all indicating lights being mounted on the under side of the desk top.

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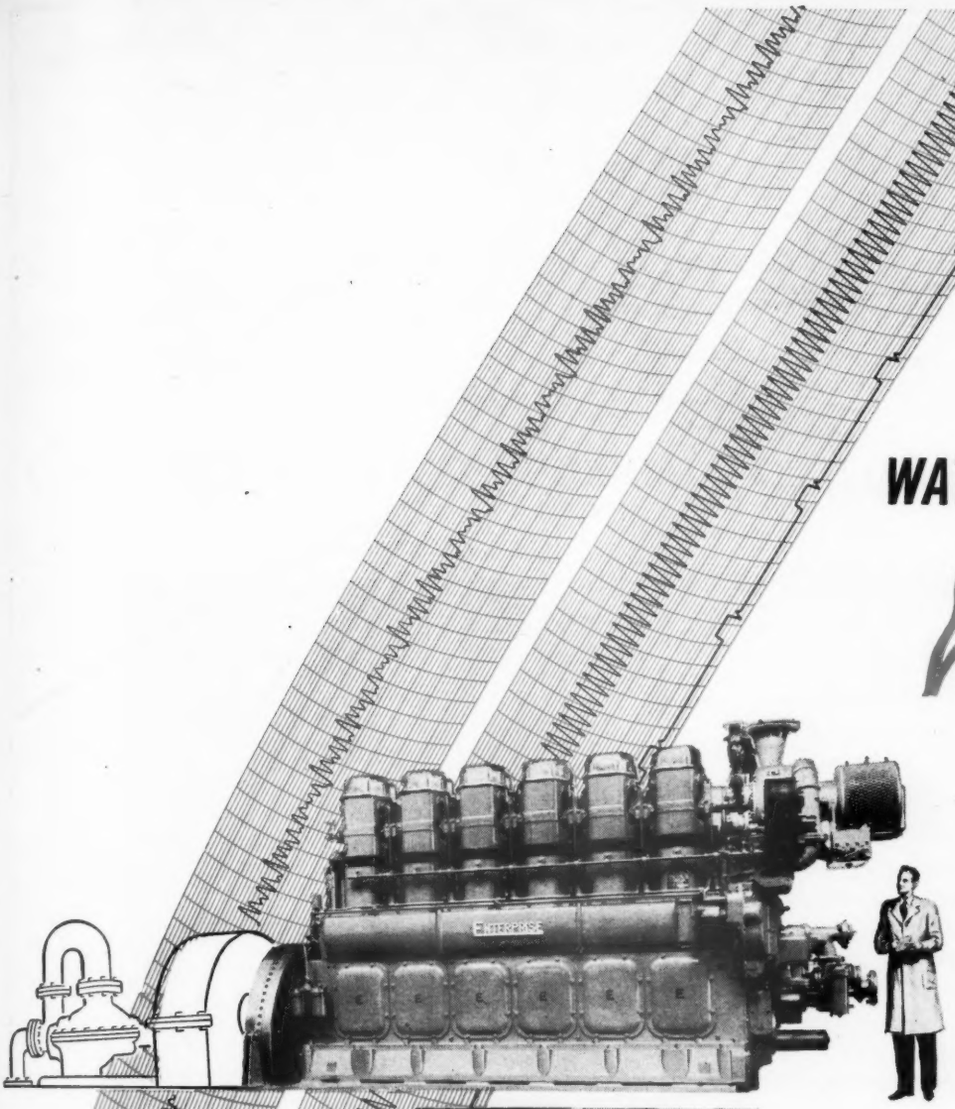

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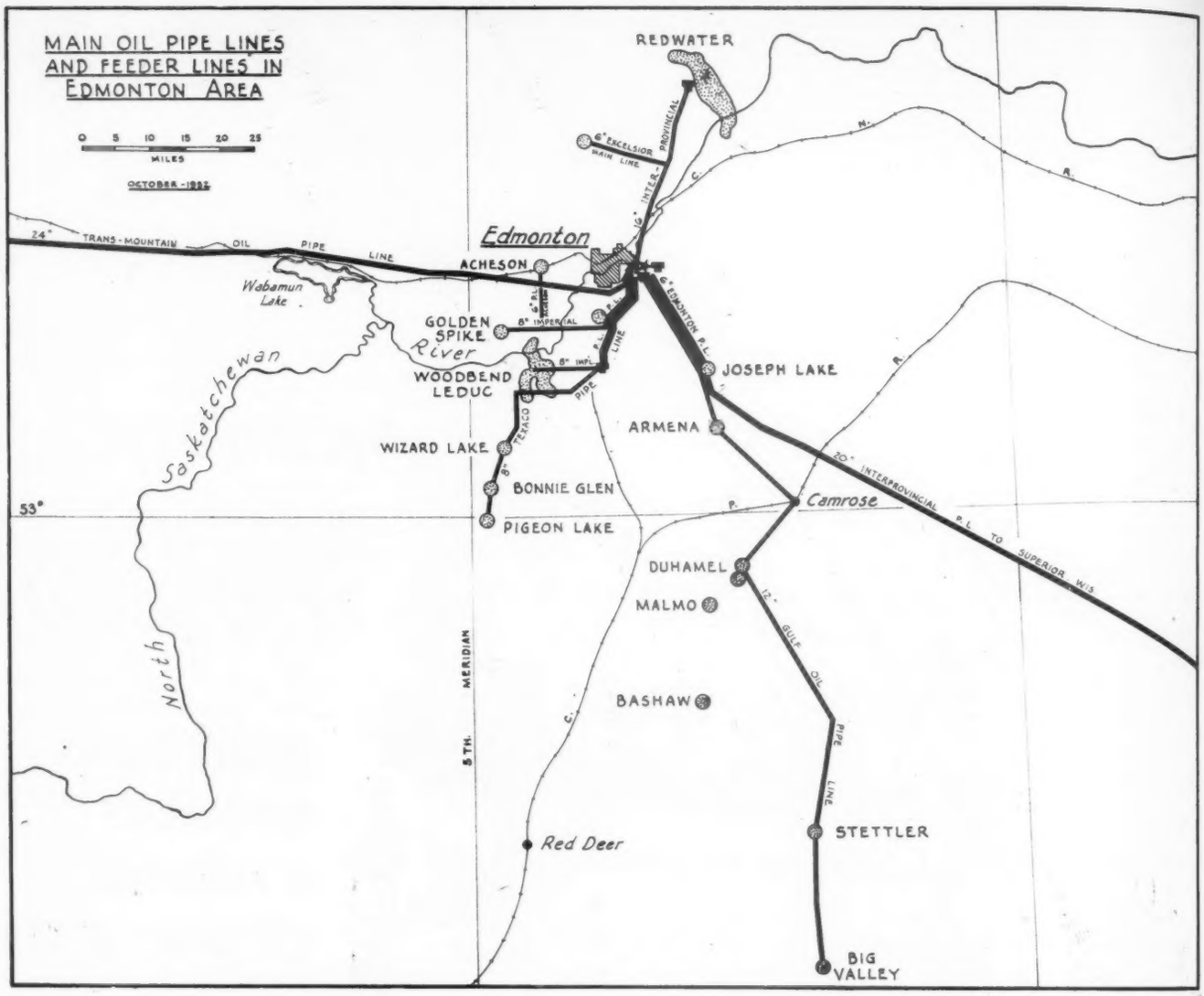


FIG. 5.

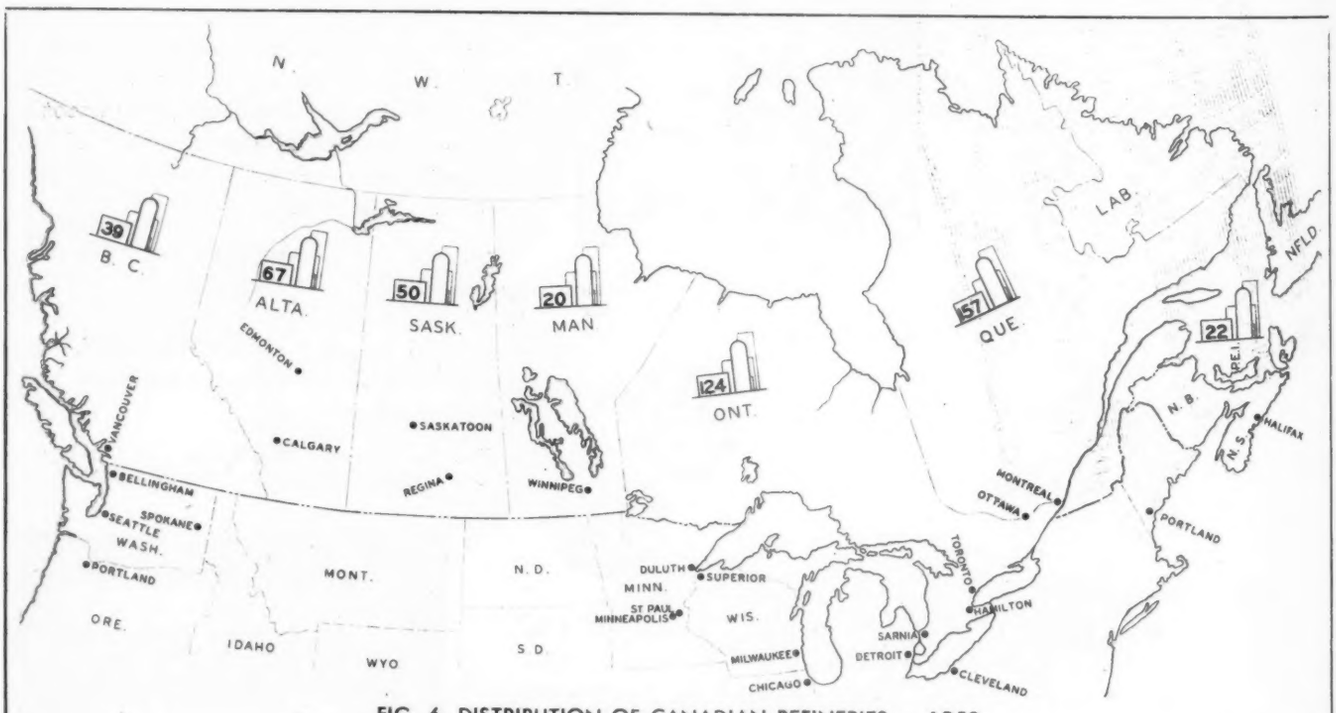
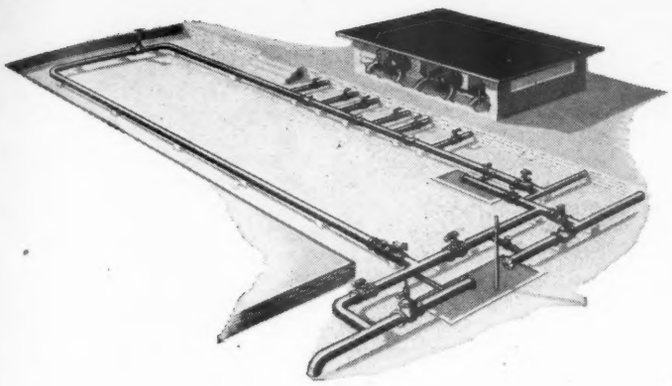


FIG. 6. DISTRIBUTION OF CANADIAN REFINERIES — 1952.
(Thousands of barrels throughput daily)



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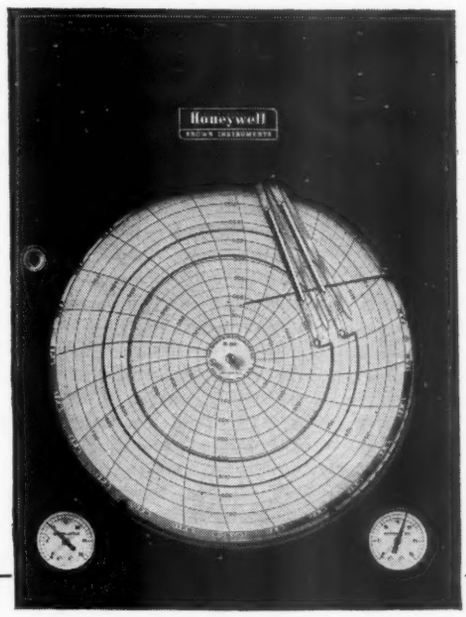

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● **REFERENCE DATA:** Write for reprint of article, "Control of Pipe Line Booster Stations."

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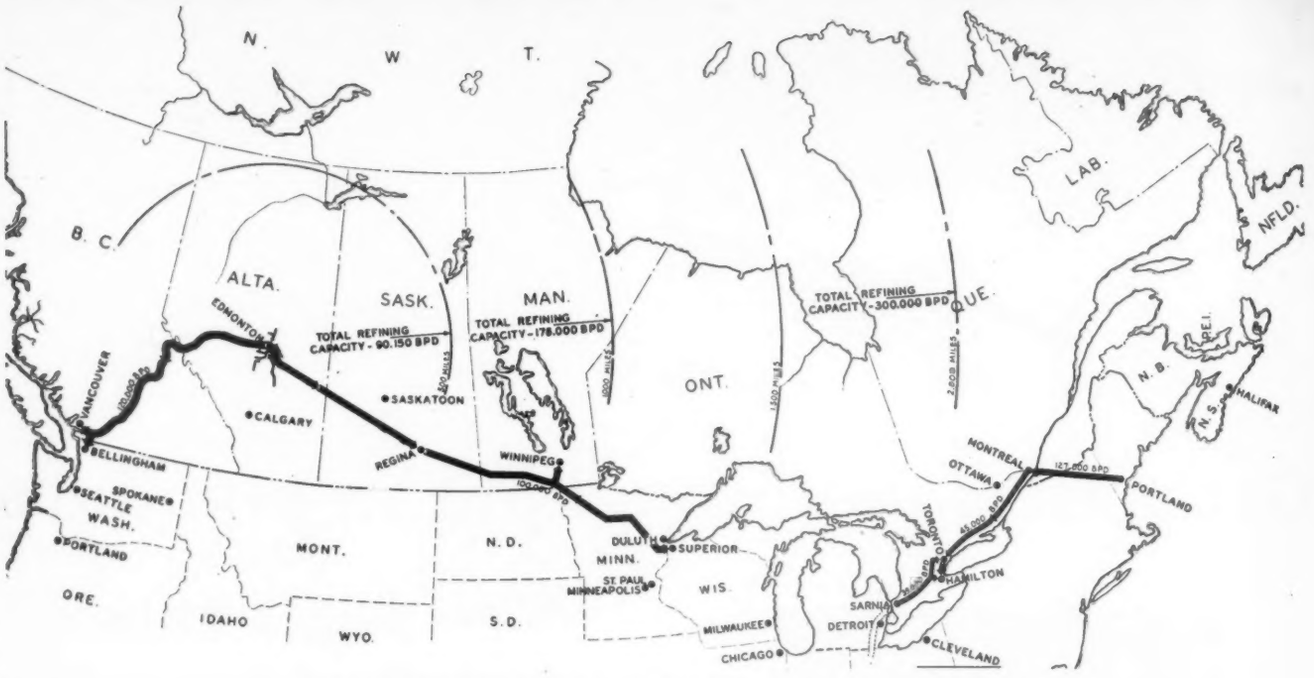

FIG. 7. CANADIAN CRUDE AND PRODUCT OIL PIPE LINES — 1952.

the war in 1939, there were 38 refineries processing a total of about 50,000,000 bbl of oil per year, of which about 17 per cent was from Canadian fields.

Previous to the discoveries in 1947, the supply of crude to the refineries and the movement of products from them were carried out by water shipment or by rail and road transport. For that reason the large refineries were situated entirely at points where they could be reached by deep-water transport from American or foreign fields.

The general distribution of the refineries by provinces is shown in the map in Fig. 6.

Trunk Pipe Lines

Our major oil transportation by the end of 1953 will be by pipe line. The three major refineries on the West Coast, the refineries across the prairies, and the refining center at Sarnia can then all receive their crude supplies from the Canadian prairies by way of long-distance pipe lines. The product demand of the great industrial area of southwestern Ontario can be largely met through the Imperial products pipe line, which moves products eastward from Sarnia to Hamilton and Toronto, and through the Trans-Northern line, which moves products westward from Montreal to Ottawa, Toronto, and Hamilton.

The lines are shown in Fig. 7, which indicates the present capacities.

The first main Canadian crude oil pipe line from the west was the Interprovincial, originating in Edmonton South, and now terminating at Superior, Wisconsin, on the Great Lakes, from whence tankers have been completing the shipment to Sarnia. That line has operated at capacity since construction was completed.

The latest trunk line is the Trans Mountain oil pipe line developed to provide a westerly movement of crude oil from the Canadian plains to the Pacific Coast. The line is 24 in. in diameter, and is about 711 miles in length. It will begin operations with an initial capacity of 120,000 bbl per day, using 3 pumping stations; and it is so designed that, with additional stations, its capacity can be brought up to 200,000 bbl or more per day, as and when required. The eastern terminal of the line is alongside that of the Interprovincial system at Edmonton South. The western terminal is at a bulk storage on Burnaby Mountain, immediately east of the city of Vancouver, from which the local refineries can be supplied.

The consumption of oil in Canada per capita is approximately two-thirds of that in the United States. The use of oil is rising rapidly, as evidenced by the increase of about 10 per cent per annum in car registration. We still have approximately 30 per cent fewer registered vehicles per person than in the United States, although those we have each consumes 10 per cent more gasoline.

We expect the production next year to be in the order of 70 per cent of our needs, and we believe that in the foreseeable future it will equal our present consumption. Ninety-five per cent of our oil is now coming from Alberta. The quality is particularly good, more than half being 34-gravity or lighter, and practically all has a low sulfur content.

The greater part of our production must of necessity be transported long distances, at tariffs that will permit the oil to be sold at world competitive prices. Within the last five years the initial framework of crude and product pipe lines has been built across Canada.

An average of our present pipe line system would show larger diameter pipe lines than in the United States, and for that reason approximately 20 per cent less steel is in use per unit of oil moved than in the United States.

The necessary pipe line systems probably can be developed most efficiently for the oil interests by the creation of independent pipe line companies. It is, therefore, pertinent for us at the present time to examine what kind of companies can be formed to do this work in Canada, and what government supervision is provided.

In order to describe the status of possible pipe line companies, it is necessary to review the legislation in some detail. The study will show that different forms of companies can be created. Some are subject to control by the Federal Board of Transport Commissioners, whereas others are not under their direction. Some will have the rights of expropriation, etc., for land; whereas others will not have that privilege.

Status of Pipe Line Companies

In order to describe the status of pipe line companies in Canada, it is necessary first to say a few words about the division of legislative powers under the British North America Act, which is our written constitution.

As you know, Canada has a federal constitution, and the legislative and executive powers are divided between the federal government in Ottawa and the legislatures in the various provincial capitals. This division of legislative powers between the federal government and the provinces was effected by the British North America Act and, in particular, by two sections, viz., No. 91 and 92 of that act. Sec. 91 provides that the Ottawa government may make general laws for peace, order, good government, etc., and also laws for a few specific subjects that are listed. Although Sec. 92 provides that the provincial legislatures may exclusively control incorporation of companies that have provincial objectives, it excludes from provincial control special types of transport such as ships, railways, canals, telegraphs, etc., which connect the provinces with one another or with points beyond any one province.

The Canadian courts also have held that Ottawa alone has the power to legislate with reference to federal compa-

nies that are incorporated to conduct business throughout the whole of Canada — even if such companies voluntarily restrict their operations to single provinces. The courts have held, however, that any provincial legislature can confer the right to carry on business in that particular province upon a company incorporated in another province.

In Canada, therefore, among the companies with federal incorporations, some may be found that restrict their operations to a single province; whereas, in contrast with them, other companies may be found with provincial charters that carry on operations throughout all the provinces and in foreign countries as well. As soon as a provincially incorporated company desires to carry out work and undertakings that connect one province with another, however, or which extend beyond the limits of the province, it becomes subject to regulations by federal legislation. The courts have not specifically stipulated that a pipe line falls within the meaning of "work and undertaking connecting one province with another, etc.," but, when a recent decision of the Supreme Court of Canada has held that a bus lines comes under such definition, pipe lines presumably also are included in the definition. Although a Dominion company is subject to federal legislation, it is also subject to provincial laws, such as those imposing taxes or relating to the holdings of land.

Most companies in Canada, whether federal or provincial, are incorporated simply by application to the appropriate federal or provincial governments. It is also possible to incorporate either under federal or provincial law, by special act of the respective legislature; but such incorporation is considerably more expensive. Certain types of companies, such as railways, banks, insurance companies, etc., have followed the practice of being incorporated by special acts of Parliament. Pipe line companies are relatively new in Canada — those that did exist up until a few years ago were mainly local gathering and distribution systems operated by companies as incidental to their other work.

In 1949 a federal pipe lines act was enacted conferring special powers and privileges upon pipe line companies when incorporated by special act by the Dominion, and since that date most of the pipe line companies that propose to operate interprovincially or internationally have been incorporated under the federal government. For example. Trans Mountain, Interprovincial, and Trans Northern have all been incorporated in this manner. Since this act has been passed, the federal government will no longer issue a charter to an ordinarily incorporated federal company specifically authorizing the company to build and operate a pipe line. It is believed that a charter could be obtained authorizing a company to carry on a pipe line business even though not incorporated by special act, but such a company would be deprived of the special powers conferred upon pipe line companies that are incorporated by special act. It, therefore, appears that all pipe line companies will tend to follow the course of being created under special federal incorporation.

Manner of Incorporation

A petition for incorporation of the company is filed with the Senate, the House of Commons, and with the Governor-General. Proceedings can then begin either through the Senate or the House of Commons. It is usual, however, to proceed first through the Senate.

The initial step is to clear the name of the proposed company in advance with the Secretary of State, then to advertise the intent to apply for incorporation in newspapers throughout Canada. In the case of pipe line companies, the form of incorporation has now become fairly standardized.

The bill is drafted, and then introduced in the Senate by a sponsoring senator; and it must pass three readings. The first reading is usually only formal. It is then referred to a Senate committee for consideration, where the sponsors of the bill support the application, and any objections from others are considered. The bill is then read a second time in the Senate; and it is then, if at all, that there is any serious debate. After passing the second and third readings in the Senate, the bill goes to the House of Commons for consideration by that body.

The bill must also pass three readings in the House of Commons, where it is also introduced by a sponsoring member of that house. Inasmuch as private pipe line company bills are not sponsored by the government, the bill has to be introduced in a meeting that is devoted to private members' business, and the time allotted for such business is very limited in the Canadian House. In view of the number of bills coming before the House during the limited time devoted to private members, it is possible for a bill to be seriously delayed at this step. After a first reading, the bill goes to a committee of the House of Commons, which hears the sponsors, any opponents of the bill, and any others interested. As in the Senate, it is during the second reading that any serious debate is likely to develop. After the bill has been given the second and third readings in the House, it goes to the Governor-General for his consent, which is usually granted forthwith.

As can be seen in the foregoing description of the incorporation by a special act of the federal Parliament, it is felt desirable in our country to insure that companies that are to have special powers, including the power of expropriation as conferred on them by the pipe lines act, should not be incorporated unless approved by the Parliament of Canada.

Special Powers

As has already been mentioned, under the 1949 pipe lines act, most important of these being the power to expropriate land, i.e., the power to take land without the consent of the owner, subject to fair payment as fixed by the courts. This act also gives the power to enter upon public or private land for the purpose of making a survey, subject to payment of compensation, and the power to cross highways, railways, electric lines, or other pipe lines.

Pipe line companies incorporated by special federal act are subject to a considerable degree of regulation by the Board of Transport Commissioners for Canada. That board, in addition to its other duties, regulates the railways and, consequently, federal pipe line companies, because certain specific sections of the railway act apply to them in the federal pipe lines act. It will be noted that the board has no jurisdiction over pipe line companies that are incorporated otherwise than by special act.

A pipe line company that has been incorporated by special act cannot begin construction until it has procured a permit from the board. In order to obtain such a permit, it must satisfy the board that the project is likely to be successful and for the benefit of Canada as a whole. In practice, it is required to prove that adequate supplies of gas or oil, as the case may be, are available for transportation through the line; that adequate markets are available at the terminus; that adequate materials are available for construction of the line, and that adequate financing has been arranged.

It is also desirable to have the support of the provinces through which the line will pass. At the present time Alberta is the only province in which large quantities of oil and gas are available for export. That province created a Conservation Board for the control of the production of both oil and gas. A permit from the Conservation Board is necessary for the export of gas from Alberta, but not for the export of oil.

As soon as the Board of Transport Commissioners has granted a permit to build a pipe line, the company may make its surveys, but it cannot begin construction until the detailed plans have been approved by the board. These plans must also be registered in the local provincial registry offices of the areas through which the line is to pass. The board must also approve of all crossings of railways, highways, and utility lines. Where the line is to cross navigable rivers, a special procedure is required. In that case, detailed plans for the river crossings must first be approved by the Federal Department of Public Works. If the plans are approved, an order-in-council can then be issued, following which an order from the Board of Transport Commissioners must be obtained.

After the pipe line has been built, the company cannot begin operating the line until a further permit has been granted by the transport board. This permit is never given prior to completion of construction; but, in practice, it is never withheld if the pipe line has been constructed in accordance with the regulations of the board.

Relations With Government

In the actual building of a pipe line in Canada, the builders come in contact with practically every department of the federal government and with the majority of the departments of the governments of the provinces through which the line has to pass:

1. In obtaining incorporation by special act at Ottawa, close contact must be established with both the Senate and the House of Commons.

2. A statute of the federal legislature prohibits the building of a pipe line for the export of oil or gas from Canada until a permit has been obtained from the Department of Trade and Commerce. Accordingly, if a pipe line is to be built to a point in the United States, a permit first be obtained from the department as well as from the transport board. The Department of Commerce also controls the vital materials required for the construction of the line.

3. The Department of National Revenue defines what customs duties are applicable to imported materials and equipment, and also what depreciation will be allowed for income-tax purposes.

4. The obtaining of easements to cross publicly owned land leads to negotiations with a number of federal departments, in which the control of property has been vested. Such departments include Public Works, Natural Resources, Indian Affairs and Department of Mines.

5. Agreement from the offices of the surveyor-general is necessary for the overall approval of maps and drawings.

6. Approval of the crossing of navigable waters must come from the Department of Public Works.

It is necessary to have the company register under the company's act in each province, in order for it to hold land and secure easements. Numerous other regulatory bodies affect the financing and the importing and the personnel arrangements. For example, engineers employed in drawing up plans, etc., must be registered as professional engineers in that province.

Without the full cooperation of all governmental bodies, federal and provincial, it would not be possible to complete construction of a pipe line at a reasonable speed. In practice, the greatest cooperation is found from all governmental authorities.

Summary

From what we have said, you will appreciate that there is no overall legislation regulating the construction and operation of pipe lines in Canada. The federal pipe lines act is the closest approach to such an overall statute; but, in fact, it merely confers certain special powers upon a pipe line company incorporated by special act of the Parliament of Canada. Essentially, these special powers are the power to expropriate private lands, the power to cross provincial and federal lands, and the power to cross highways, railways, and other public utility lines — if necessary, without the consent of the owner. In return for these special powers, such a pipe line company subjects itself to regulation by the Board of Transport Commissioners for Canada.

The position is clearly illustrated by the fact that it has been possible for a pipe line to be constructed and operated completely free from any regulation from the Board of Transport Commissioners. There is a major pipe line in that position at present. Similarly, there are a number of provincial, incorporated companies that have constructed, and are now operating, pipe lines within a province, and such companies are not subject to regulation by the Board of Transport Commissioners.

A company with a provincial charter has, of course, the basic disadvantage that its line cannot cross the border of the province.

In view of the complexities of the possible ways in which a company may be formed, the question naturally arises as to how long it takes to become established. The time required is largely dependent on the speed with which clearance is obtained through the Senate and House of Commons committees and the time used in preparing the necessary evidence for the Board of Transport Commissioners. Some companies have been refused a charter, when it was considered that the proposed development was not necessary at that time. The applications of others have had to wait an appreciable time for proof of the necessity of the project, approval of the federal and provincial governments concerned, and evidence of the availability of necessary financing and engineering.

A company can be established relatively quickly when its proposal is fully approved by both government and industry. As an example, the application of the Trans Mountain Oil Pipe Line Company passed all the Senate and House of Commons committees within about one month in the spring of 1951. The necessary surveying and financing were arranged during the following summer, permitting the application to be submitted; and complete authorization was granted by the Board of Transport Commissioners during the first part of December, 1951.

With reference to costs other than the normal operating expenses occasioned by legal fees, the making of surveys and engineering estimates, and arranging the financing, the only fixed charge is the fee payable in connection with a private bill, which is proportional to the authorized capital.

The acts concerned, their interpretation, and the general regulations affecting pipe lines in Canada are still all relatively new. We need some changes in both legislation and rules for our operations to reach the degree of efficiency that all parties are striving to bring about. To pick one example, if 25 of the streams crossed by a line such as Trans Mountain are to be defined as navigable rivers, then it is desirable to employ some form of authorization more simple to obtain than an order-in-council for each crossing, which is now required. The present general system has been made to work, and work efficiently, but that has been accomplished only by the wholehearted effort of both government and industry cooperating in the closest possible manner.

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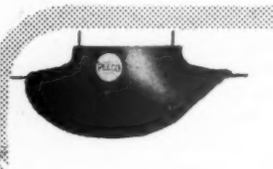
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DIESEL BOOSTS STATION'S CAPACITY

Most powerful unit on Tulsa-Lima system of Gulf raises output 46 per cent and increases pressure differential 400 psi

INSTALLATION of a 1170-hp Alco diesel in the Gulf Refining Company's State Line station has raised current throughput to 47,000 bbl per day and will give the station an estimated pumping capacity of 60,000 bbl per day at a pressure differential of 900 psi when additional pipe line facilities are installed to deliver that volume to the station. The unit is the most powerful engine in the 15-station line and its potential pumping volume represents a gain of 46 per cent with an additional 400 psi compared with the previous engine's output.

This 700-mile pipe line was built originally in 1930 to transport crude oil from Tulsa to refineries at Cincinnati, Toledo, and Pittsburgh. Northern terminus of the 10-in. line is Spencerville Junction (10 miles southwest of Lima, Ohio) where it joins the Buckeye system. Originally, the line had 14 pumping stations, 13 with a total of 28 Alco diesels rated at 316 hp and one station with three 200-hp DeLa Vergnes. All engines drive reciprocating pumps. In 1936, line capacity was increased by installation of one 340-hp Busch-Sulzer diesel at each station.

The performance record of the original engines is worth noting. During the first 11 years of operation, from 1930 to 1941, the engines were in service an average of 75 per cent of the time. In the 11 years since 1941, all the engines have run an average of 97 per cent of the time. Thus, the original Alco diesels have run more than 165,000 hr in the 22 years. Today these stations continue their heavy operating schedule without standby equipment. Each engine is in actual service an average of 97 per cent of the time, is available for service 98½ per cent of the time, is shut down for maintenance only 1½ per cent.

In 1941, the line met the demand for greater throughput by increasing the speed and output of all existing engines, getting an estimated 360 hp from the 316-hp units, and raising line pressure from 700 to 800 psi. Deliveries to Lima were further increased by construction of a new station at State Line on the Indiana-Ohio border, 38 miles south of the junction point with the Buckeye system. This station went into service in February, 1942, with a 425-hp Cooper-Bessemer diesel driving a 3-stage Goulds centrifugal pump. Volume was 41,000 bbl per day with a pressure differential of 500 psi.

Finally, in 1950, it became necessary to increase deliveries to Lima by another 6000 bbl per day. Rather than adopt some makeshift to provide for immediate needs, Gulf engineers decided on a major expansion of this key station not merely to deliver the 47,000 bbl per day then required but to allow for anticipated future production of 60,000 bbl at a suction pressure of 100 psi and a discharge of 1000 psi.

To accomplish this, the company installed the line's most powerful engine, a diesel rated at 1170 hp. This latest prime mover, like the original engines of the line, is an Alco diesel of the 4-cycle McIntosh and Seymour design. It is an 8-cylinder unit with 12½-in. bore and 13-in. stroke, developing its rated horsepower at 650 rpm. Driving through a gear unit of 5.409 to 1 ratio, the diesel turns a 6-stage United Iron Works centrifugal pump at 3550 rpm. The pump is rated at 1750 gal per minute at 2660-ft head. Engine and pump currently are handling an average of 47,000 bbl per day but have the capacity to pump 60,000 bbl at a pressure differential of 900 psi when pipe line capacity is increased to handle that volume.

In the installation of the new diesel and accessory equipment, Gulf engineers exhibited painstaking care and considerable ingenuity.

The diesel burns crude oil taken from the pipe line and stored in a 1200-bbl tank. The operators try to load up the tank with good fuel but take whatever is available when they have to. The crude is transferred from storage to a 250-gal day tank by an automatic float-controlled gear pump. The oil is heated to 110 F by heat transfer from engine jacket water and then is put through a centrifuge, after which it is pumped to a 250-gal clean-oil tank. The clean-oil tank has an overflow line back to the dirty-oil tank so that it is possible to keep the centrifuge running for five or six hours, running the oil through several times.

From the clean-oil tank, the fuel flows by gravity through a cellulose filter to the engine's booster pump, which delivers the oil through another filter to the individual fuel injection pumps. Surplus from the pumps returns through a spring-loaded relief valve to the clean-oil tank.

The Alco is lubricated with Gulf Dieselmotive B, a detergent-type oil, which is circulated through the engine under pressure by an engine-driven pump. Included in the circuit is a shell-and-tube oil cooler utilizing engine jacket water to cool the oil. An automatic thermostatic valve bypasses oil around the cooler as necessary to maintain the desired temperature. Some oil is piped from the pressure side of the engine circulating pump to a duplex waste-packed filter. Lube handling is simplified by a highly flexible arrangement of piping. Drums of oil are emptied into a 500-gal tank and thereafter are handled entirely by a motor-driven transfer pump. Lube can be pumped to or from the engine crankcase, lube cooler, discharge line, bypass line, and sump tank. Thus, if the oil became contaminated, it would be possible quickly to empty the entire system and replace the dirty oil with a full charge of clean lube. Engine down time would be held to a minimum.

To give the engine maximum protection and keep wear and maintenance down, the lube is kept in peak condition. The oil is tested on regular schedule to check on acid, solids, and viscosity.

Engine cooling water is circulated through the closed cooling system by a centrifugal pump driven off the engine. Water at 147 F is pumped through the diesel's jackets, leaving the engine at 160 F. Some of this hot water is used to heat the fuel oil, some in a unit heater to heat the plant office. The jacket water is cooled by the incoming crude oil of the main line in a shell-and-tube heat exchanger with 1645 sq ft of cooling surface. Cool water from the exchanger is used to cool pump bearings, mechanical seals, gear unit lube, and engine lube.

Waste heat from the exhaust gases is used to heat the plant and the arrangement is flexible and convenient. The hot gases pass through a jacketed line to the horizontal silencer on the roof. A motor-driven blower draws warm air from the jacket and discharges it into the engine room in cold weather. Louvers in the discharge section of the blower can be reversed in hot weather so that the blower vents to the atmosphere and cools and ventilates the plant.

Intake air for the engine is drawn through an oil-bath filter on the roof to the exhaust-driven turbocharger on the diesel. A gage and alarm panel holds a multi-point exhaust pyrometer, pressure gages on lube, water, and fuel, and alarms on low lube pressure and high or low jacket water temperature. Starting air for the diesel is provided by a motor-driven compressor. The plant has a 17.5-kw diesel-generator set to provide electric power to run the motor-driven auxiliary equipment and to supply emergency lighting if outside power sources are cut off.

State Line station operates as a booster station in a closed system, receiving oil from Dublin station 40 miles to the south and pushing it along to Spencerville Junction and Lima to the north. To insure that the powerful pumping unit does not pump the incoming line dry, automatic valves actuated by pressure of the incoming oil throttle pump output.

Gulf's big diesel is operating the heavy schedule required of all prime movers on the line, averaging 97 per cent running time and even greater availability. * * *

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plan to protect your pipe line against corrosion!

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ANY pipe line, whether large or small, is a big investment—an investment that should be properly protected.

That's why it's wise, when planning a new pipe line, to include Bitumastic Enamel in your design plans and specifications. Bitumastic Enamels, manufactured from selected coal-tar, have proved they can prevent corrosion. Many oil and gas pipe lines, laid 20 and 30 years ago, are still giving good service today, thanks to these durable Enamels.

Why not let your Koppers representative work with you from original planning through to final operations? He will be glad to assist you to get the most out of your protection dollar by giving you complete details and estimates.

KOPPERS BITUMASTIC ENAMELS
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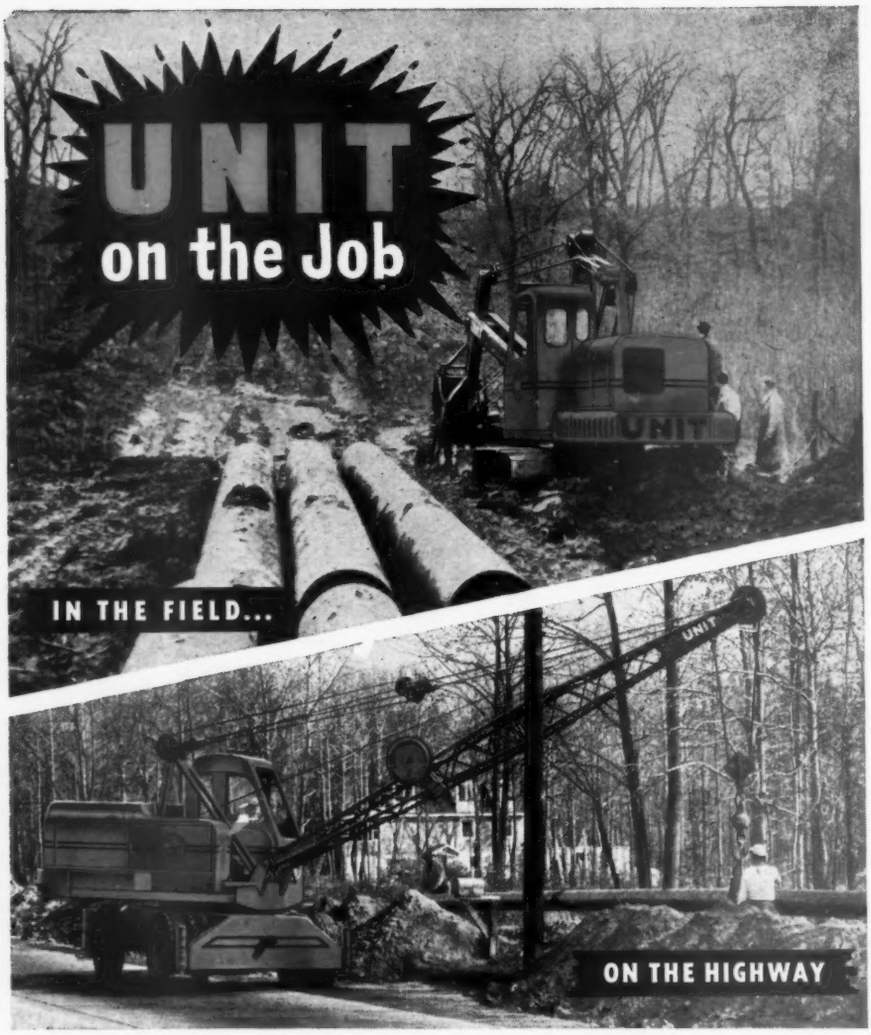
KOPPERS COMPANY, INC., Tar Products Division, Dept. 251-T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

To obtain more information on products advertised see page E-59



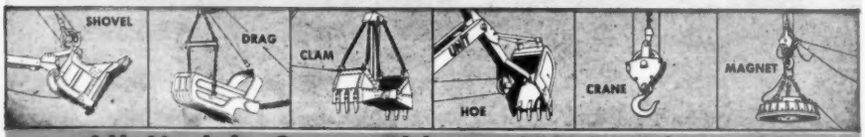
Where Pipeline Goes...UNIT Goes!

In the field where the going is tough, UNIT TRENCHOES have the traction and power for continuous ditching to meet pipeline schedules. For laying pipeline along the right-of-way, where the going is smooth, the self-propelled mobile UNIT offers road travel speed, plus accurate lift and swing control. Designed for speed and stability, UNIT crawler and mobile equipment are built to meet every trenching and handling job required in pipeline construction work.

SEE FOR YOURSELF: *Let us send you our novel TV Brochure. It illustrates the complete UNIT line.*

UNIT CRANE & SHOVEL CORPORATION
6603 WEST BURNHAM STREET • MILWAUKEE 14, WISCONSIN, U. S. A.

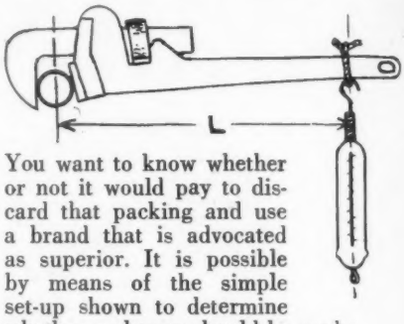
½ or ¾ YARD EXCAVATORS...CRANES UP TO 20 TONS CAPACITY
CRAWLER OR MOBILE MODELS . . . GASOLINE OR DIESEL



All Models Convertible to ALL Attachments!

How to Do Your Own Friction Testing

The accompanying sketch shows how easy it is to set up a testing device that can be used in a number of ways in almost any plant. Let us say, for example, that you are dissatisfied with the packing you are using on a centrifugal pump.



You want to know whether or not it would pay to discard that packing and use a brand that is advocated as superior. It is possible by means of the simple set-up shown to determine whether a change should be made.

Proceed as follows: Place a long-handled pipe wrench on the shaft, as indicated in the sketch, and at a measured distance L from the center of the shaft attach a spring scale, also as indicated. Then pull on the spring scale, causing the shaft to rotate, and note the amount of the pull in pounds. The direction of pull must always be at right angles with the measured distance L. It is not necessary to rotate the shaft rapidly. Repeat the experiment several times and note the reading on the spring scale each time until you are certain that you have the correct pull. Call it "Pull No. 1". Then remove the packing and replace it with the brand you want to try out. It is well to operate the pump for a while to make certain that the packing does not leak and that it is "worn in". In fact it would do no harm to run the pump for a week or a month so as to be perfectly fair with the new brand. Then, repeat the above test with the set-up precisely as before, same distance L, same everything. Determine "Pull No. 2" with the new brand of packing.

You are now ready to do the figuring. You found, for example, that "Pull No. 1" was 20 lb and "Pull No. 2" was 10 lb. Subtract the 10 from the 20 and you have 10 lb difference. Multiply that difference by the distance L in inches, then by the rpm of the pump, compressor, or whatever the machine is, and multiply the product by 0.0000159. The result is the horsepower loss due to your present packing. To make it perfectly clear let us say, now, that the distance L is 20 in. and the rpm of the pump is 800. Applying the above rule you will have $10 \times 20 \times 800 \times 0.0000159$ and you will find the answer to be 2.54 hp, which is the loss due to excess friction of your present packing. Call it, roughly, 2½ hp.

It is now obvious that if a horsepower per year costs you $40 the present packing is costing you $100 per year too much, or, $\$40 \times 2\frac{1}{2}$ equals $100.

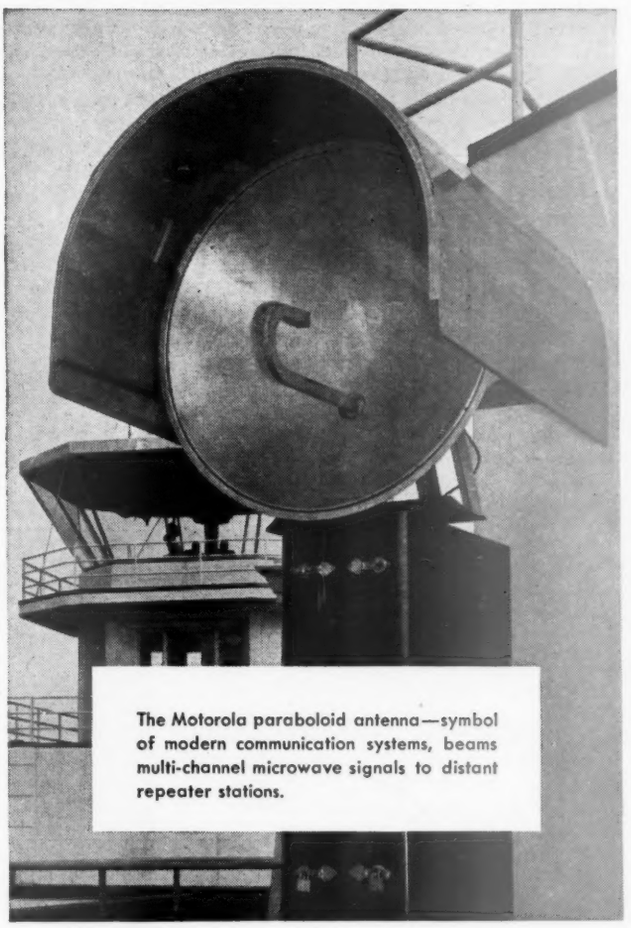
Your problem is to select the packing that will remain tight at all times, that will operate with least pull at distance L from the center of the shaft, and that will cause minimum wear on the shaft. The lever used, of course, need not necessarily be a pipe wrench.—W.F.S.

Motorola Microwave is a job-proved success!

MOTOROLA—*builder of more than 70% of the completed and operating Microwave Systems in the Pipeline field can cut costs, speed operations for you*

Motorola engineers, with over 24 years experience and research in mobile radio communication, have installed *more than 70%* of all operating pipeline microwave systems. Flashing through space with the speed of light, voice messages, telemeter, teleprinter and supervisory control signals span thousand-mile pipelines with instant 2-way contact—cut communication costs, save vital man-hours, speed industrial operations.

Motorola custom-tailored systems provide full communications facilities for industry, transportation, utilities and public services. Microwave and VHF radio tie-ins blanket plant areas, railroads, pipelines and entire cities. Your business, too, can profit from Motorola 2-way radio—write today for friendly Motorola engineering service.



The Motorola paraboloid antenna—symbol of modern communication systems, beams multi-channel microwave signals to distant repeater stations.

The Ever-Growing List of Companies Using MOTOROLA Communication Systems Reads Like a "Who's Who" of American Business

Allis-Chalmers
Thompson Products, Inc.
Johnson and Johnson
Eastman Kodak
Timken
Kaiser Steel Corp.
American Bridge Company
Kellogg Company
Gardner-Denver
Pennsylvania RR
New York Central RR
Public Service Company of Northern Ill.
Rock Island RR
Sinclair Oil Company
Southern California Gas Co.
Shell Oil Company
Southern Pacific RR
Staley Mfg. Co.
Ford Motor Co.
Mid-Valley Pipeline Co.
Weyerhaeuser Timber Co.
Esso Standard Oil Co.
International Minerals and Chemical Corp.
Missouri Pacific RR
Texas Illinois Natural Gas Co.

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Rogers Majestic Electronics Ltd., Toronto, Canada

Tulsa Corrosion Course To Be Held March 4-6

The fourth annual Tulsa Short Course for pipeliners has been scheduled for March 4, 5, and 6, according to committee chairman W. A. Hutchison, chief corrosion engineer for Sinclair Pipe Line Company.

Designed specifically for foremen, superintendents, field engineers, and inspectors, the school will cover "Practical Control of Pipe Line Corrosion" by group discussions, lectures, and field demonstrations led by practical authorities such as Fred M. Cloninger, Texas Pipe Line Company; Lancy F. Heverly, Great Lakes Pipe Line Company; F. M. Hieronymus, Barrett Division of Allied Chemical and Dye Corporation; Marshall E. Parker, Jr., Cormit Engineering Company, and Y. W. Titterington, Pipe Line Anode Corporation.

Again sponsored by the Tulsa Section of the National Association of Corrosion Engineers, the short course will be under the direction of a committee headed by W. A. Hutchison and including Edw. T. Bartolina, Moorlane Company; James C. Bell, Service Pipe Line Company; Hugh A. Brady, Pipe Line Anode Corporation; Melvin E. Maddox, Pittsburgh Coke and Chemical Company, and T. D. Williamson, Jr., T. D. Williamson, Inc.

Basically the same program will be offered as last year when approximately 200 pipeliners from throughout the country participated.

Registration fee of $10 will cover a buffet supper and transportation by chartered buses to demonstration site near Tulsa. Headquarters will be at the Mayo Hotel where room reservations should be made by the individual. Registration forms can be procured from Hugh A. Brady, Box 996, Tulsa, Oklahoma.

Bulk Storage Facilities Completed at Charleston

The Air Material Command has formally accepted the $2,341,000 petroleum bulk storage facility at North Charleston, South Carolina and placed it in operation. Constructed under the direction of the Charleston district of the U. S. Army, Corps of Engineers, this storage depot for airplane gasoline and jet fuel has capacity of 23,500,000 gal.

General American Transportation Corporation of Chicago supplied and erected seven steel storage tanks, each with a capacity of 80,000 bbl and fitted with Wiggins Hidek floating roofs for vapor conservation. General contractor for the entire project was Merritt-Chapman and Scott Corporation, New York.

Tankers arriving from Gulf ports in the southern United States, or from overseas, will pump their cargoes ashore through 12-in. flexible rubber hoses connected with reducers to twin 18-in. diam over and underground pipe lines. These pipe lines will carry the fuel 2½ miles to the Charleston bulk storage facility. Overground pipe line is supported by concrete piers and timber piles.

Salt water will be pumped through the lines from dock side to purge them whenever there is a change in the type of fuel to be sent from the dock to the storage facility. This will be done by an electrically operated centrifugal pump connected to a 10-in. outboard pipe line at the dock. Upon arriving at the facility, the fuel will be boosted into the 80,000 bbl storage tanks by three electrically operated centrifugal pumps.

All fuel arriving at the storage depot will be filtered before going through the booster pumps to the tanks. This will insure removal of any foreign solids that might damage the delicate valves in the pumps. All fuel leaving the tanks will also pass through separators to remove any water resulting from condensation in the tanks and lines, before it is pumped to the three 41-ft long tank truck loading racks. There are also two 400-ft long loading racks for railroad tank cars.

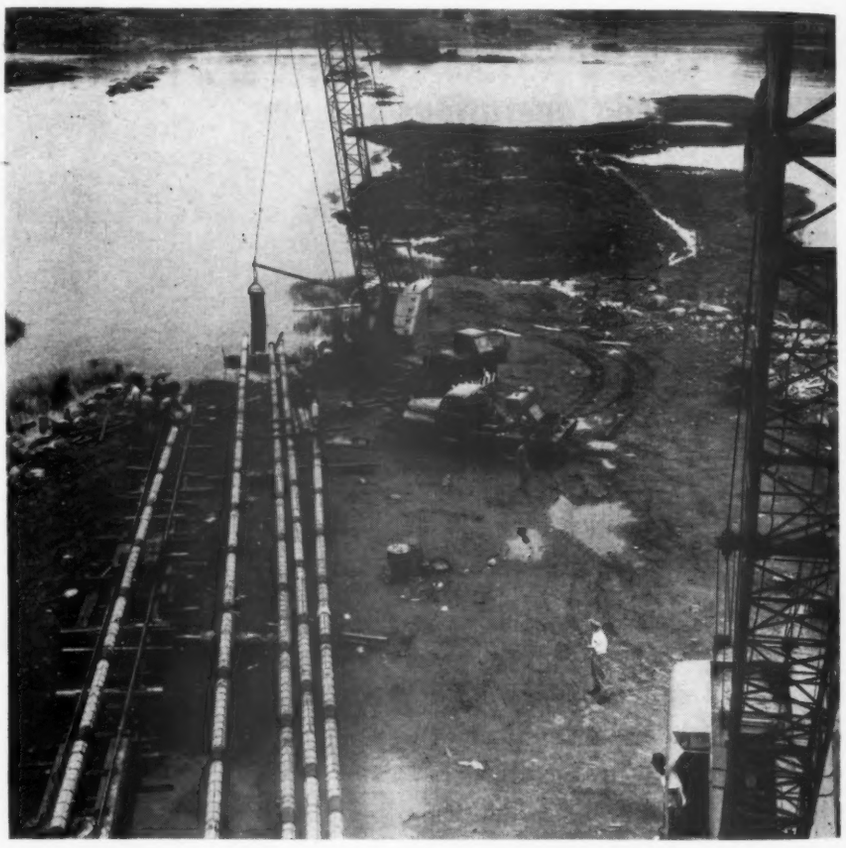
Booklet on Pipelining Issued by Caterpillar

"Pipelining On Schedule," an 8-page booklet that tells the story of diesel engines in pipelining machines and equipment, has been released for distribution by Caterpillar Tractor Company, Peoria, Illinois.

The book is well illustrated. Picture captions tell the story of Caterpillar electric sets and Caterpillar-powered cranes, shovels, ditchers, and compressors proving their worth on pipe line construction jobs being carried out under all types of natural conditions.

Also included are cutaway views of the single orifice Caterpillar fuel injector and the Caterpillar governor.

"Pipelining On Schedule" — Form 30579—is available from your Caterpillar Distributor or from Caterpillar Tractor Company, Peoria 8, Illinois.



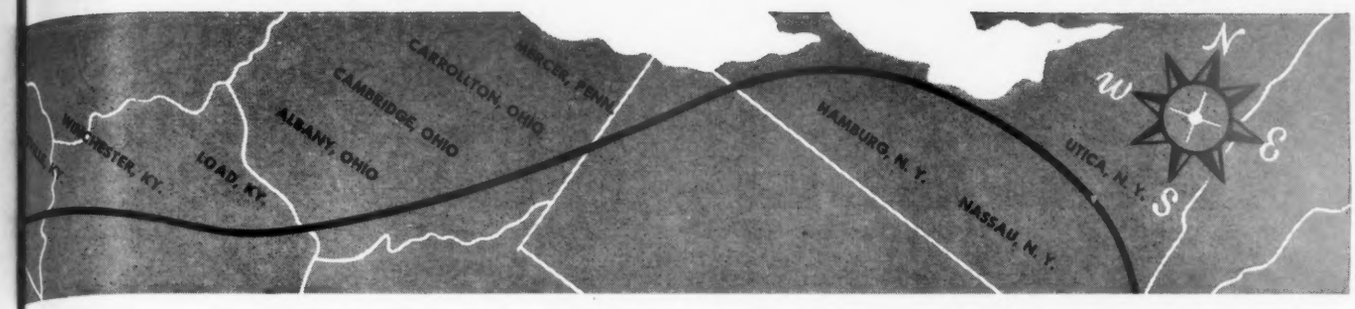
New England Power Service Company pulling 8-in. pipe across the Annisquam River.

Annisquam River Crossed by Pipe Line

A natural gas pipe line and river crossing recently constructed for the Gloucester Gas Light Company at Gloucester, Massachusetts, by United Engineers and Constructors, Inc., of Philadelphia, Pennsylvania, represents the most northeasterly penetration of natural gas in the United States.

The 8-in. pipe line at Gloucester extends from a Northeastern Gas Transmission Company metering station approximately 3½ miles along the coastal highway. Just as it enters this celebrated fishing port it crosses under the Annisquam River. A new gas handling plant by United Engineers is a part of this construction.

Crossing beneath the 1500-ft wide Annisquam was constructed by dredging a trench in the river bottom, prefabricating sections of the pipe line ashore, and then successively welding these sections together as the line was dragged into the trench and pulled across river from the opposite shore. Because of marshy approaches and quicksand bottom at the crossing, fill was used for construction of the pipe line right-of-way on shore. Field work was done by Merritt-Chapman and Scott Corporation.



2000-Mile Tennessee Gas Line —Longest in Country— operating 98 Worthington Compressors

46 Worthington UTC Engine Compressors help pump 1,250,000,000 cu ft a day

All along the Tennessee Gas Transmission Company line, from the Gulf Coast to the New England states border, you'll find Worthington UTC gas-engine compressors on the job.

At last report, more than 1,250,000,000 cu ft of gas was being sent through the line daily. A total of 46 Worthington UTC engine compressors are now installed at eight different compressor station locations.

All these UTC units use the Worthington *Uniflo timed-scavenging method*—one big reason for the smooth performance they give. Uniflo scavenging assures a "clean sweep" of burned gases.

While built primarily for pipeline gas compression, the UTC is ideal for many other jobs such as: pressure maintenance on oil wells; varied service in natural gasoline plants; on solvent extraction, vapor recovery, recycling and stabilization of gases in oil refineries; in petro-chemical processing of products made from natural gas under pressure; and in many refrigeration applications.

If your process requires gas compression and you have a suitable gas available for fuel, the Worthington Uniflo UTC can do the best possible job for you.

Sizes range from 1,000 to 2,000 hp. For further information, contact the nearest Worthington District Office or write for Bulletin S-500-B23B.

Worthington Corporation, Engine Division, Buffalo, N. Y.

EK.2.2

OUTPERFORM A WORTHINGTON

WORTHINGTON

Engine Compressors

To obtain more information on products advertised see page E-59

Pipe Lines Needed for Peak-Day Gas Demand

Natural gas utilities will have to carry on a continuing program of new pipe line construction to meet expected peak-day demands for gas if all potential customers are to be given service through 1955, according to a report of the Petroleum Administration for Defense made public by Secretary of the Interior Oscar L. Chapman.

Figures submitted by the utilities indicate that supply will be sufficient for peak-day loads in the 1952-53 winter if the weather is normally cold. Peak-day demands of all potential customers are expected to rise to 38 billion cubic feet by the winter of 1955-56, however, up 50 per cent from the 1951-52 peak-day requirement of 25.3 billion cubic feet, the report revealed.

Utilities already have planned expansion to take care of much of the increase. The report points out, though, that they will need an additional daily supply of about 1 billion cubic feet in the winter of 1953-54, 1.7 billion cubic feet in 1954-55, and almost 3 billion cubic feet in 1955-56 if all potential customers are to be supplied.

"It is obvious from the figures," Deputy Petroleum Administrator J. Ed Warren commented, "that until the industry gets sufficient pipe line capacity and increases its underground storage and other peak-shaving devices, it will have to put up with a control of the growth of its market in some areas.

"We in PAD hope to remove our Order No. 2, which restricts extensions of natural gas uses in certain areas, just as soon as the defense need for the order passes. This date, we believe, is not too far in the future. It will, then, be up to the industry to continue close cooperation with state regulatory bodies in insuring any curbs on a possible runaway gas market that may be necessary."

Statistics on natural gas supply and demand for the years through 1955 are included in a comprehensive, detailed study of "Gas Requirements and Supplies of the Gas Utility Transmission and Distribution Industry."

This study was prepared by the Gas Planning Division of PAD from reports and forecasts submitted to the agency by 200 gas utilities whose sales total more than 90 per cent of the annual sales of the entire industry.

The figures—projected by PAD to cover the entire industry—indicate that gas supplies probably will be adequate to cover overall annual needs for gas if present expansion plans are realized. In two regions, though, reported presently assured and presently planned supplies together would fall substantially short of potential demand in the winter of 1955-56, and additional facilities are needed—in the Appalachian-Middle Atlantic area (District I-B) and the Upper Great Lakes area (District II-A).

"Two things must be remembered about the supply-demand figures for these areas," Warren emphasized. "One is that they are for the areas as a whole, not for individual utilities within those areas. The second is that the figures on possible requirements are based on an assumption that service might be extended to all the potential customers who would like it. To the extent that extensions are necessarily curbed, the actual requirements will be below the potential."

District I-B embraces New York, New Jersey, Pennsylvania, Ohio, Kentucky, West Virginia, Virginia, Maryland, Delaware, and the District of Columbia.

District II-A embraces Wisconsin, Illinois, Michigan, and Indiana.

The PAD study reveals that if the gas utilities are to supply all potential demands, they will have to lay almost 10,000,000 tons of pipe from 1952 through 1955.

Detailed requirements of pipe for the industry are set out as follows:

	1952	1953	1954	1955
By size of pipe				
16 inch and larger	2,050,000	1,540,000	1,400,000	1,210,000
Under 16 inch	710,000	790,000	740,000	590,000
	2,760,000	2,330,000	2,140,000	1,800,000
By usage				
Transmission and underground storage	2,320,000	1,880,000	1,690,000	1,380,000
Distribution	440,000	450,000	450,000	420,000
	2,760,000	2,330,000	2,140,000	1,800,000

"The important point," the report emphasizes, "is not that a particular tonnage is required for a particular year but rather that by 1955, if the industry is to connect all demands, it will need almost 10,000,000 tons of steel; of this total, 6,200,000 tons represents steel of pipe sizes 16 in. and over. If the 700,000 tons probable allocation in 1952 is deducted, this would leave 5,500,000 tons of large-size line to be constructed in the three years 1953, 1954, and 1955.

"Based on 1950 and 1951 large-line construction, during which years such activities were about at a maximum, it would appear the potential large-line construction from the standpoint of construction facilities and pipe availability will probably fall somewhat short of potential requirements in the three-year period."

(In 1950 the industry laid 1,723,000 tons of large lines, and in 1951, 1,728,000 tons.)

PAD earlier had made public (PAD News Release 487) four charts and a number of tables from the full study which revealed:

1. Demands for gas are expected to rise from the 49,700 million therms of 1951 (estimated) to a potential of 69,800 million therms in 1955, a 40 per cent increase. (A therm is a unit of heat measurement equal to 100,000 British thermal units.)

2. Natural gas will supply an increasingly large percentage of the demand and is expected by 1955 to represent 96 per cent of the total gas sales to ultimate consumers in the nation. (The percentage rises to better than 99 if sales of natural gas to mixed-gas utilities are included.)

3. Demands for natural gas for residential space-heating are expected to increase at a greater rate than other demands.

4. In spite of the rapid increase in demand for natural gas for residential space-heating, industrial sales will continue to account for the major part of total sales.

The full study contains a summary of the results of the analysis of data from contributing utilities and other sources.

Change in Ownership of Natural Gas Storage

The Federal Power Commission has modified the certificate issued last September to Natural Gas Storage Company of Illinois, Chicago, Illinois, to the extent of providing that the storage gas will be owned by utility customers of two affiliates of the storage company instead of by the affiliates themselves as originally authorized.

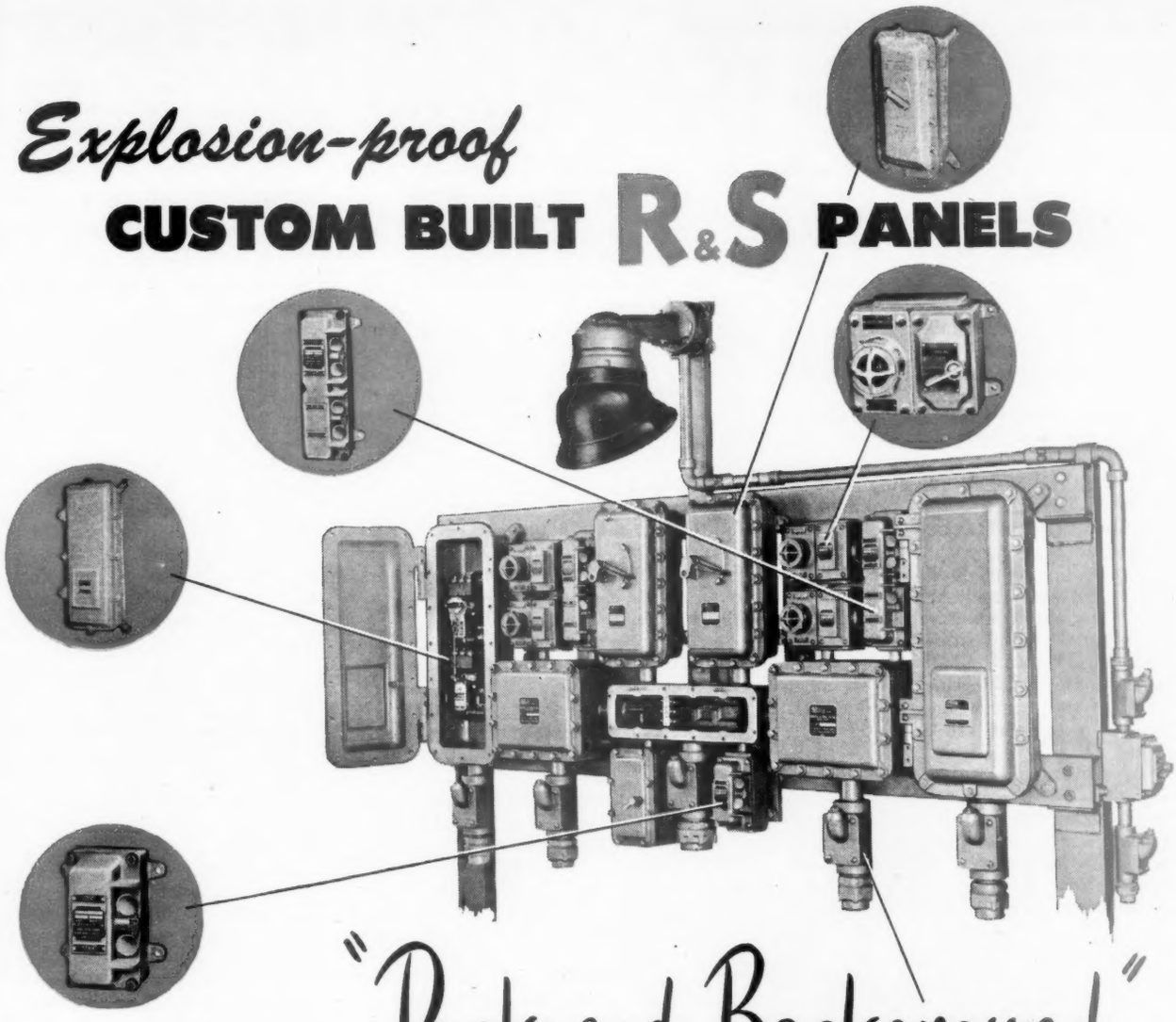
The storage company had first proposed to store natural gas for the account of Natural Gas Pipeline Company of America and Texas Illinois Natural Gas Pipeline Company, both of Chicago. The three companies are subsidiaries of Peoples Gas Light and Coke Company, also of Chicago. Last month, however, the storage company filed an application requesting the modification, to permit ownership of the gas by the affiliates' customer companies.

Under the new plan, Natural and Texas Illinois will continue to sell the present contract volumes to their customer utilities, but will make delivery to the storage company for their customers' account of the volumes of gas designated by each customer utility for storage. This storage service will be performed under a tariff to be filed with the FPC by the storage company, and under service agreements to be entered into directly with the customer utilities of Natural and Texas Illinois.

Change in ownership of the storage gas is necessary, the storage company said, to enable it to effect certain agreements designed to protect the institutional investors holding the debt securities of the storage company against the chance of geological or other difficulties encountered in the operation of the storage project. To obtain this security, the storage company will enter into an agreement with several large utility customers, under which it will be agreed that in the event the storage company's gas tariff is inoperative for any reason, or fails to become operative by June 1, 1954, the customers will periodically advance funds sufficient to meet all of the storage company's operating expenses, taxes, and debt service requirements. The agreements also will provide that any such advances will be applied as credits to future payments due from each of the customer utilities, when and if the tariff becomes operative.

Explosion-proof

CUSTOM BUILT R&S PANELS



HAVE A "Packaged Background"

Russell & Stoll custom built panels utilize standard R & S equipment as "packaged" components wherever possible. Note how well this better, faster, more economical construction method has been employed on the oil pipe line plant panel illustrated.

R & S thereby by-passes all the uncertainties, delays and expense of "special design" equipment. R & S panels are factory built, sealed and tested, offering simplified construction and pre-engineered performance.

No panel can be better than any of its component parts. And every R & S panel has benefits that stem from selection and use of precision-made units from the complete R & S explosion-proof line. R & S circuit breakers, switches, pilot lights, push button stations and other control devices have standout advantages such as removable front covers, abundant wiring space and conduit openings — in addition to individual features that meet all standards, *plus*.

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PRECISION-BUILT ELECTRICAL EQUIPMENT—SINCE 1902

Tide-Water Installs Teletypewriters

The Tide-Water Pipe Company, Ltd., the oldest long distance pipe line company in existence, recently had Bell System private line teletypewriter service installed for operational and administrative purposes. The new communications system replaced their privately owned Morse telegraph system. The Tide-Water Pipe Company, with headquarters at Bradford, Pennsylvania, is a common carrier of crude petroleum. Its 289-mile pipe line runs from the oil fields at Bradford, Pennsylvania, to the refinery at Bayonne, New Jersey, and has a delivery capacity of 20,000 bbl a day.

The Tide-Water Pipe Company prides itself in the fact that it pioneered in pipe line construction having engineered and built the first long distance pipe line in 1878. J. Z. Van Tine, the company's president, said: "Many of the original tools, pumps, and engines used in this first pipe line were developed by Tide-Water engineers and manufactured by pump and tool companies according to Tide-Water specifications. The first pumps used were steam-powered. These remained in use, to some extent, until 1941. At the present time, however, all pumps on the line are 'full diesel operated'."

To control and regulate the flow of oil, and to insure prompt action in emergencies, communication is required with all stations on the pipe line. Recognizing the need for a communications system from its inception, Tide-Water constructed its privately owned Morse telegraph system across almost unbroken forests paralleling the original pipe line from Coryville to Williamsport, Pennsylvania. As time passed and the pipe line was extended eastward to the Atlantic seaboard so was the telegraph system. With the growth of towns and the development of farming communities privately owned pole lines and facilities became more difficult and costly to maintain. Also there was the problem of obtaining expert station engineers who were, at the same time, efficient Morse operators. Thus, in order to provide an economical and more flexible system that could be operated by personnel having no Morse training, Tide-Water decided to replace its own communications system with private line teletypewriter facilities leased from the Long Lines Department of the American Telephone and Telegraph Company.

The service recently installed by Long Lines connects the headquarters office, all pumping stations, and the delivery terminal by private line teletypewriter service. This service enables the chief dispatcher to transmit communications to all pumping stations and the delivery terminal at the same time. It permits prompt transmission of orders to distant stations enabling the dispatcher to efficiently control the movement of crude oil, through the pipe lines at the desired operating pressures. To supervise the flow the dispatcher receives periodic reports from each station throughout the day and night.

In addition to keeping intermediate stations currently informed regarding pumping schedules, the teletypewriter service is also useful to transmit other data such as the condition of the pumps as well as inventory and administrative reports.

The teletypewriters on the system are equipped with selective signaling devices whereby each station can call any other station or all other stations on the line.

At Rixford, Pennsylvania, oil from one of the lines of the Northern Pipeline Company flows into Tide-Water's for delivery to Bayonne. At this junction point close coordination on the part of both companies is required to regulate the flow. Besides the teletypewriter on Tide-Water's circuit, the Northern Pipeline Company has a Bell System teletypewriter machine installed at this location to communicate with stations along its own pipe line which runs from Oil City, Pennsylvania, to Buffalo, New York. In addition to its use to regulate the flow of oil, the Northern Company's machine is used to acknowledge to the Northern dispatcher at Oil City the receipt of oil delivered to Tide-Water for transportation over its pipe line to the east.

George B. Valentine, chief telegraph operator, at teletypewriter.

World's Longest Private Microwave System Completed

A master key to the world's longest private system of microwave radio communications was presented in Washington, D. C., to Claude A. Williams, president of the Transcontinental Gas Pipe Line Corporation, by Dr. W. R. G. Baker, General Electric vice president and general manager of the G-E Electronics Division.

The presentation was made at a dinner attended by Transcontinental and G-E officials, at which the communications system was formally accepted. The system, engineered and built by General Electric at Syracuse, New York, is now operating along the 1840-mile Transcontinental pipe line from Falfurrias, Texas, to Newark, New Jersey.

Engineering acceptance tests of the $1,500,000 system were completed in December. It is capable of providing the equivalent of 12 telephone lines, or channels. This is accomplished by a chain of 59 microwave stations, which relay extremely-high-frequency signals from one to another in narrow flashlight-like beams.

At present, only 7 of the 12 channels are being used. They provide radiotelephone facilities necessary for the operation and maintenance of the pipe line, such as the hourly reporting of gas pressures from all compressor stations to the Houston office, and the control of gas flow by the dispatcher in Houston.

The remaining unused channels may later be utilized for additional voice communications, or for carrying signals to control motors, read meters, open and close valves, and perform similar tasks.

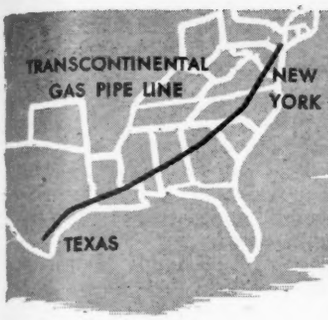
Two "party lines," or channels, extend the entire 1840-mile distance. The remaining channels now in use provide a number of "private lines" between the main Houston office and other key district offices along the pipe line.

Communicating facilities are provided at 23 of the 59 microwave stations. The remaining 36 are automatic repeaters, with no provisions for communicating, other than for servicing.

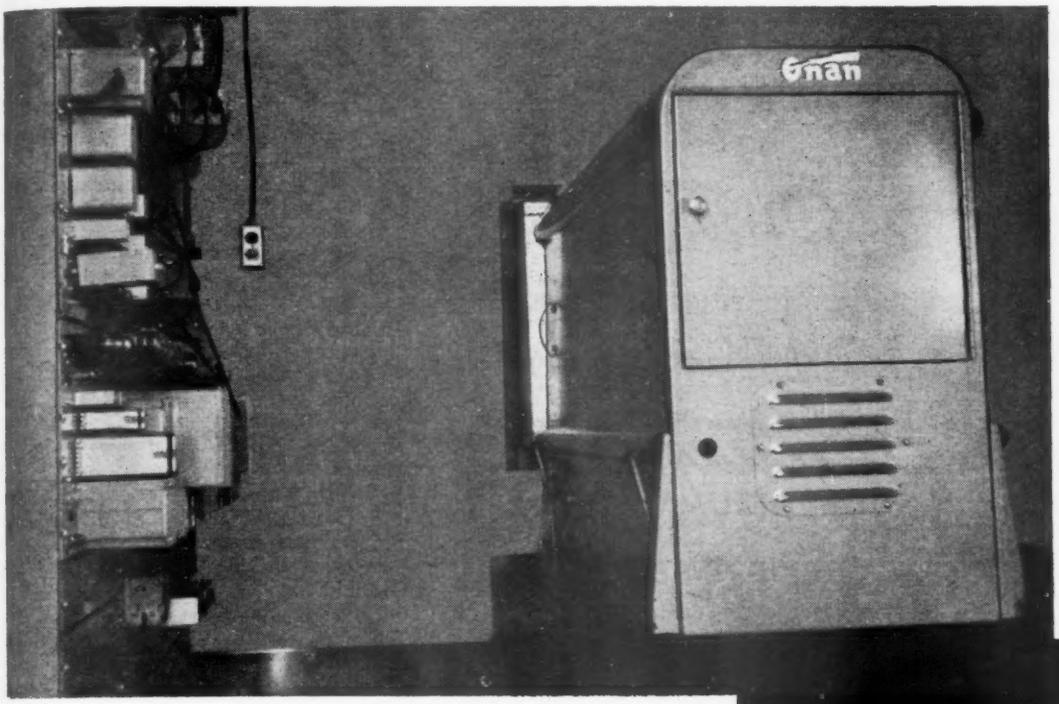
Communicating stations are situated at either end of the network, at two Transcontinental division offices, and at all 19 compressor stations. Three microwave "spurs" from the main system connect three other division offices with the main office at Houston, and other points in the system.

There are 58 towers in the system, ranging from 50 to 300 ft in height. They are an average distance of about 30 miles apart.

The main microwave system operates at 2,000,000 kilocycles. The three "spurs", connecting division offices at Baton Rouge, Louisiana; Atlanta, Georgia, and Culpeper, Virginia, with the main system, operate at 960,000 kc.



43 Onan Standby Plants Guard Pipe Line Microwave System



●5,000-Watt A.C. Onan Standby Electric Plants supply emergency power for Transcontinental's unattended microwave relay stations whenever the commercial power source fails.

Transcontinental's 1840-mile microwave system is protected exclusively by Onan Standby Electric Plants!

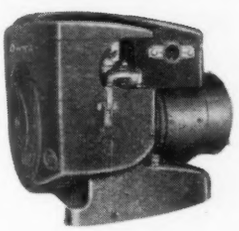
At each of the 43 repeater stations, a Model 5GO-1R14 stands by ready to deliver 5,000 watts of 115-volt, 60-cycle current whenever the regular commercial power source is interrupted. Onan Automatic Line Transfer Controls instantly switch the electrical load to the plants which start without any human supervision.

The Onan engine-generators provide emergency electric power for the microwave relay transmitters, tower warning lights and ventilating equipment. These units also supplied primary power at several repeater stations during the long period of time required to make difficult powerline hookups, thus allowing the system to function as soon as microwave installations were completed.

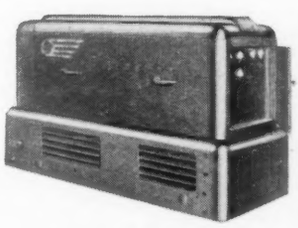
Transcontinental's microwave system is vital to the operation of its pipe line; and Onan Standby Electric Plants are insurance against interruptions in the functioning of that system. With emergency power available, this company will always be able to maintain dependable and efficient control of the movement of its natural gas.

For complete information and engineering assistance in providing standby power protection for your microwave system, write to:

ONAN STANDBY PLANTS



3,000-WATT A. C. Models powered by a 2-cylinder air-cooled Onan engine. Extremely compact, require very little installation space. Automatic Line Transfer Controls available to start and stop plants serving unattended relay stations.



5,000 TO 35,000-WATT A.C. Models powered by 4- and 6-cylinder water-cooled engines. Compact, fully housed units as shown (open types available). Line Transfer Controls for completely automatic operation can be supplied for all sizes.

POWER & LIGHT FOR EVERY NEED
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PRODUCTS

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New Unloading Dock to Be Constructed For Esso

A new dock for unloading petroleum product barges will be constructed on the Kanawha River at Boomer, West Virginia, near Charleston, for Esso Standard Oil Company, by The Contracting Division of Dravo Corporation. It will be the fourth river dock constructed for Esso by Dravo in the last few years.

The new dock will consist of three steel sheet pile mooring cells, 16 ft in diam, along 285 ft of harbor line. Two of the cells are to be connected to the shore with 50-ft walkways on which unloading pipe lines are supported.

Many Problems Discussed In Papers On Coatings

The five papers readied for presentation during the protective coatings symposium during the NACE Chicago Conference from 9 to 11:30 a.m. Friday, March 20, at Hotel Sherman cover a variety of subjects in the coating field.

Papers scheduled are as follows:

"Coating Research and Applications in Atomic Energy Operations," by C. D. Watson. This paper includes information recently declassified by the Atomic Energy Commission. The manner in which the AEC is using coatings is expected to be interesting.

"Field Tests of Exterior Coatings for a Pipeline Conveying Fuel Oil Heated to 200 F," by E. R. Stauffacher and B. R. Davidson, relates field tests and experience in selection of protective coatings for 41 miles of 8-in. schedule 30 pipe. Tests include application of external pressure at predetermined locations, electrical resistance measurements and cold bends. Final data and conclusions will be presented.

"Filiform Corrosion," by Maurice VanLoo, presents a theoretical explanation of this type of corrosion and is illustrated with time-lapse motion photography. Filiform corrosion apparently has no direct relationship with the metallurgical pattern of the surface, light, biological activity of inhibitive pigments. The directing force is explained on the basis of concentration cells.

"Effects of the Composition of Steel on the Performance of Organic Coatings in Atmospheric Exposure," by F. L. LaQue and J. A. Boylan gives at least a partial answer to the question as to whether the improved atmospheric corrosion resistance of alloy steels is of any advantage when they are painted. Paint was a common pigmented baking alkyd primer with pigmented baking urea modified alkyd top coat automobile finish, with and without zinc phosphate pretreatment.

"Weld Seams and Weld Flux Effects on Coating Life," by A. J. Liebman covers performance data important to corrosion engineers developed by the author.

Discussion leaders for the pipe line coatings session have been named as follows by E. R. Lopez, session chairman, of Barrett Division, Allied Chemical and Dye Corporation:

For general construction contractors —Ray L. Smith, Ray L. Smith and Son, El Dorado, Kansas.

For coating equipment manufacturers —R. E. Shackleford, Perrault Equipment Company, Tulsa, Oklahoma.

For consulting engineers—Hugh L. Hamilton, A. V. Smith Company, Bala-Cynwyd, Pennsylvania.

For pipe line owners—A. D. Simpson, Jr., United Gas Corporation, Houston, Texas.

For factory coating applicators—M. M. Bowen, Hill, Hubbell and Company Division General Paint Corporation, Cleveland, Ohio.

For coal tar coating manufacturers—W. F. Fair, Jr., Koppers Company, Westfield, New Jersey.

For asphalt coating manufacturers—Wayne E. Broyles, Brance-Krachy Company, Inc., Houston, Texas.

For petroleum base coating manufacturers—Wayne E. Schultz, Dearborn Chemical Company of Chicago, Illinois.

For asbestos felt maufacturers—E. J. Liggett, Johns-Manville Sales Corporation, Tulsa.

For glass wrapper manufacturers—R. W. Farriss, Owens-Corning Fiberglas Company, Newark, Ohio.

Following brief remarks by each, time will be provided for questions from the floor.

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For "on the spot" Weld Testing—

This quick, handy device cuts finished coupons for accurate weld testing... coupons have smooth, straight, parallel sides—thus eliminating all machining, grinding, and filing.... Coupons are cut by the alternate operation of two cranks that move the torch at a rapid, constant speed for a predetermined distance each direction. Cuts coupons up to 10" long and up to 1½" wide. Adjusts to pipe of any length as well as any diameter 3½" or larger.

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HAMMOND IRON WORKS KEYES TANK DIVISION CASPER, WYOMING PROVO, UTAH

On the Site:

coating and wrapping of underground storage bottles for Washington Gas Light Co.

THE WASHINGTON GAS LIGHT COMPANY installation is a combination of underground high pressure natural gas storage and propane-air. The steel bottles are laid out in blocks averaging 40 bottles, each block storing approximately one million feet of gas. The bottles are installed in the ground with a minimum of 3'6" of cover, after being coated and wrapped. Cathodic protection is also provided. This combination of measures provide positive protection against underground corrosive attack.

The steel bottles for the Washington Gas Light Company installation were coated and wrapped at the site with equipment specially developed for this type of work by Pipe Protection Service, Inc.

This equipment, as well as portable equipment for the coating and wrapping of pipe from ¾" to 30" diameter, is available for operation at customers' railhead or storage sites.

Pipe Protection Service, Inc.

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Pipe Line News

New Products Pipe Line Terminal at Toledo

A new Marathon refined products pipe line terminal is being put in operation by The Ohio Oil Company at Toledo, Ohio.

With a total storage capacity of 6,552,000 gal, the terminal will receive refined products by pipe line from the company's refinery at Robinson, Illinois. Products to be handled include Marathon "Cat" gasoline, Marathon Ethyl gasoline, kerosine, No. 1 and No. 2 fuel oil, and diesel fuel. These products will be distributed by truck transport to ten bulk plants serving Marathon outlets.

The terminal is the fourth to be built by Ohio Oil to facilitate the distribution of its products in its five-state marketing area in Illinois, Indiana, Ohio, Michigan, and Kentucky. Similar installations are at Indianapolis and Muncie, Indiana, and Lima, Ohio. A fifth terminal is planned for Mt. Vernon, Indiana.

The Toledo terminal is situated on a 30-acre tract two miles east of Toledo at the intersection of Seaman Street and Lallendorf Road. Storage facilities include one 2,310,000-gal tank, four 1,050,000-gal tanks, and one 42,000-gal tank.

All Contracts Awarded On Standard Products System

All contracts have now been awarded for construction of the new 309-mile 12-in. Standard Oil Company (Indiana) refined products pipe line from Sugar Creek, Missouri, to Dubuque, Iowa, according to R. E. Nelson, Jr., general manager of crude oil supply and products pipe lines.

Work on four contracts has been completed. The four completed sections include: (1) A 2.6 mile section including a crossing of the Missouri River, by Pentzien, Inc.; (2) a 36-mile section extending northeast from the Missouri River crossing, by Sheehan Pipe Line Construction Company; (3) seven creek and river crossings installed by Ray L. Smith and Son, Inc., and (4) a group of highway and railroad crossings installed by R. B. Potashnick.

In other construction under way, Sheehan Pipe Line Construction Company has two spreads working toward each other on an 84-mile section between Polo and Unionville, Missouri.

On the remainder of the line—about 186 miles—O. R. Burden Construction Corporation has three spreads working.

Pipe stringing contractor is Parkhill Truck Company, Tulsa, Oklahoma.

The Refinery Engineering Company of Tulsa, Oklahoma, is doing the station work at Sugar Creek pumping station.

The steel strike delayed pipe deliveries and caused a major setback in completion of the line, originally scheduled for January 1, 1953, he added.

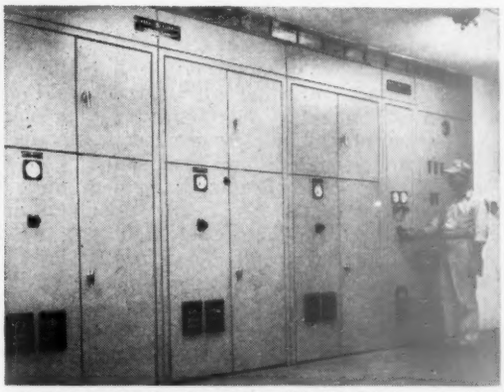
The new pipe line will connect the Sugar Creek refinery near Kansas City with the Dubuque pipe line terminal on Standard's present Northwest products pipe line from its Whiting, Indiana, refinery to Moorhead, Minnesota.

"This connection permits greater

ENGINEERING REPORTS:

AUTOMATIC SEQUENCE CONTROL of pumping units at The Texas Pipe Line Company's Erath, La. station is provided from G-E control desk. Pressing a single push button automatically initiates entire starting or stopping cycle.

FAST INSTALLATION of G-E control equipment at Erath station (above) was facilitated by complete wiring diagrams furnished by G-E engineers.



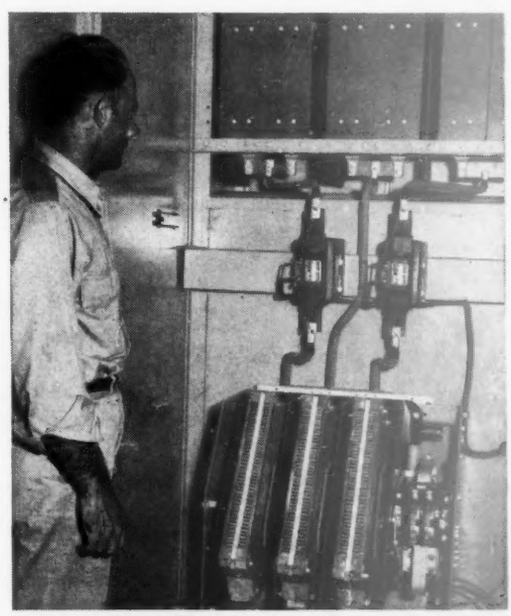
HIGH-VOLTAGE MOTOR CONTROL is provided by this G-E Limitamp assembly. Panel at right contains sequence-control and alarm-bell relays.

Engineered control system speeds station start-up

G-E equipment for automatic operation of pump motors installed fast at The Texas Pipe Line Company

Feature of two pumping stations recently put in operation by The Texas Pipe Line Company at Erath and Houma, La., is the automatic station-control system engineered by General Electric. Centralized in one operator's console are push buttons for automatic sequence control of each main pump motor and associated valves and blowers; simplified piping diagram; and a protective and alarm system. Complete wiring diagrams supplied by G.E. saved this company drafting time, cut installation cost, and helped speed the station's initial start-up.

Automatic station-control systems are only one of many ways in which G-E application engineers can help you cut pipeline pumping costs. For full information, contact your G-E Apparatus Sales representative or write for Bulletin GEA-5423 to General Electric Company, Section 661-40, Schenectady 5, N. Y.



DEPENDABLE SWITCHING of high-voltage motor currents is provided by air-break contactors, shown under current-limiting pressure fuses.

Engineered Electrical Systems for Oil Pipelines

GENERAL ELECTRIC

XUM

flexibility in the company's pipe line distribution facilities for refined petroleum products," according to Nelson. "Pumping operations can be reversed, if necessary, to supply parts of Iowa and Missouri with petroleum products from the Whiting refinery."

The Sugar Creek-Dubuque products pipe line is an addition to four other products pipe lines operated by Standard in seven midwest states. The pipe lines now in operation are 1422 miles long. Manager of the products pipe line department is Sam L. Jackson.

Standard maintains construction headquarters in the Bookin Building at Ottumwa, Iowa. S. L. Cox is construction superintendent.

Special Training Given Key Trans Mountain Men

Training program for Canadians who will take over senior positions with Trans Mountain Oil Pipe Line Company is well under way in the United States, according to an announcement by H. H. Anderson, vice president and general manager, with headquarters in Vancouver.

Two groups, each comprising eight men, left Vancouver recently for nearly three months intensive study of pipe line and pumping station operations and maintenance in 43 centers in Illinois, Missouri, Louisiana, Texas, Colorado, Utah, Nevada, California, and Oregon.

Upon completion of their courses the men will return to take up duties at points along the 718-mile Trans Mountain line between Edmonton and Vancouver.

Construction of the $90,000,000 project is scheduled for completion at the end of August; and oil will flow from the Alberta fields to the Pacific Coast in October.

Senior group, together with positions prior to joining Trans Mountain are:

E. S. Davis, assistant superintendent, Imperial Oil's Winnipeg refinery.

C. D. Bailey, chief engineer, John Inglis, Toronto, manufacturers of industrial equipment.

R. F. B. Taylor, finance officer, Canadian Bechtel, Ltd., Toronto, and prior to that, member of Canada's Foreign Exchange Control Board.

E. C. Hurd, superintendent, Mercury Oil Company, Oklahoma City.

T. A. Haslett, project engineer, Imperial Oil's Sarnia-Toronto products pipe line.

Derrick Humphreys, experienced as manager of mining companies in Australia and South Africa.

H. C. Priest, varied experience in industrial engineering, lately with British Columbia Electric.

J. D. Menzies, manager, Turner Valley Pipe Line.

All are Canadian citizens except Humphreys who is an Australian.

Speaking of the training program, Anderson said: "The lectures which will be given in the field during the first six weeks will give a broad cross-section of the philosophies and practices of several companies, so that the men can then spend the succeeding five weeks on individual study assignments. Then, after a nine-day home leave, they will return to Vancouver and for the next month will consider the Trans Mountain problems in detail, and how they are going to organize their duties to cope with them."

Anderson will lead this group during the first two weeks of the tour. A. F. Terrill, general superintendent, will take the second two weeks, and D. W. Rohrback, chief engineer, the third two weeks.

Anderson, Terrill, and Rohrback are seasoned pipe line executives who form a part of the Trans Mountain training team, and are responsible for putting the pipe line into operation.

The second group comprises men who are scheduled for positions as terminal pump station or mechanical supervisors. They will understudy skilled operators at tank farms and pumping stations, and will also visit factories in St. Louis, Missouri, and Portland, Oregon, where the large diesel engines and pumps are being built for Trans Mountain.

Leader of this group is F. L. Underwood, an American. He is training supervisor of the training team.

Second group: Gregory Short, Burnaby; J. H. J. Bennett, Burnaby; E. Kelgard, Winnipeg; E. Forrester, Vancouver; J. Cowling, Vancouver; D. Fraser, Vancouver; E. C. Halowell, Vancouver; W. G. Whitehead, Edmonton.

Another group of candidates for terminal pump station and mechanical supervisory positions has just returned from a similar trip. Further training by actual employment in erection of equipment is now in progress at Trans Mountain's three pump stations at Kamloops, British Columbia, Edmonton, and Edson, Alberta.

New Line of Salt Lake in Operation

Petroleum products are now moving through the new 330-mile pipe line from Salt Lake City to Boise, Idaho.

This new 8-in. line was built parallel to an existing pipe line at a cost of $8,000,000. It was constructed and will be operated by Salt Lake Pipe Line Company, a subsidiary of Standard Oil Company of California.

Completion of the new facility boosted throughput capacity from 22,000 bbl to 39,500 bbl a day. With the addition of supplementary pump stations it would be possible to increase the route's carrying capacity to 45,000 bbl a day.

When the project was announced earlier this year, it was explained that the need for additional transport capacity from Salt Lake City into southern Idaho has been increasing since completion of the first portion of the line three years ago, and that as more oil products became available at Salt Lake City it was decided to lay the parallel route.

The new pipe line was built in less than three months by construction crews of Macco Corporation, and Engineers Limited Pipe Line Company.

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IGT Publishes Data on Properties of Nitrogen

Nitrogen is chemically inert, and is a non-combustible diluent lowering the heating value of natural gas in direct proportion to its concentration. The cost of transmission of natural gas per Btu unit is directly influenced by the concentration of nitrogen, which as a high molecular weight constituent increases the horsepower required for pumping.

Proposals have been made to remove nitrogen prior to transmission as a means of increasing pipe line effectiveness. Further, the removal of propane and ethane from high-nitrogen natural gas for petrochemical manufacture requires the removal of nitrogen to insure maintenance of heating value requirements on the gas. Also, the storage of liquefied natural gas for meeting peak loads requires separation of the nitrogen to insure uniformity of the natural gas when removed from storage.

The engineering design of plants to separate nitrogen from natural gas requires accurate data on the thermodynamic properties of nitrogen over a wide range of conditions. To provide charts of value to the natural gas industry, researchers at the Institute of Gas Technology, affiliated with Illinois Institute of Technology, have recalculated the usual thermodynamic properties of nitrogen on the basis of more recent fundamental data from the published literature.

"Thermodynamic Properties of Nitrogen," by O. T. Bloomer and K. N. Rao, IGT Research Bulletin No. 18, presents the properties in tabular form and as charts of enthalpy vs. entropy, and of compressibility factor as a function of temperature and pressure. The range of the tables and charts is from saturated liquid at minus 320.4 F to superheated vapor at 500 F, and pressures from 10 to 1500 psia. Properties tabulated are specific volume, enthalpy, entropy, and the fugacity-to-pressure ratio. For the superheated vapor region, calculations were based on zero-pressure specific heat data and a new equation of state.

As a supplement to the bulletin, the "Mollier Chart for Nitrogen" and "Compressibility Chart for Nitrogen" have been reproduced full scale (grid 10 x 10 to the inch) on heavy paper, 22 in. x 34 in. They are issued as a set only, and are sold separately from the bulletin.

The address of the Institute of Gas Technology is 17 West 34th Street, Technology Center, Chicago 16, Illinois.

South Central Region NACE to Meet in Tulsa

The South Central Region of the National Association of Corrosion Engineers, comprising the states of Colorado, Kansas, Oklahoma, Arkansas, Louisiana, Texas, and New Mexico, has scheduled its 1953 meeting in Tulsa, Oklahoma. Tentative dates are October 7-9 and the Mayo Hotel has been designated headquarters.

The region's 1952 meeting, held in New Orleans, October 1-3, attracted more than 500 persons.

New Executive Committee Appointed for AGA

A new executive committee comprised of nine officers and directors of the American Gas Association has been appointed to aid in conducting the affairs of the association for the coming year.

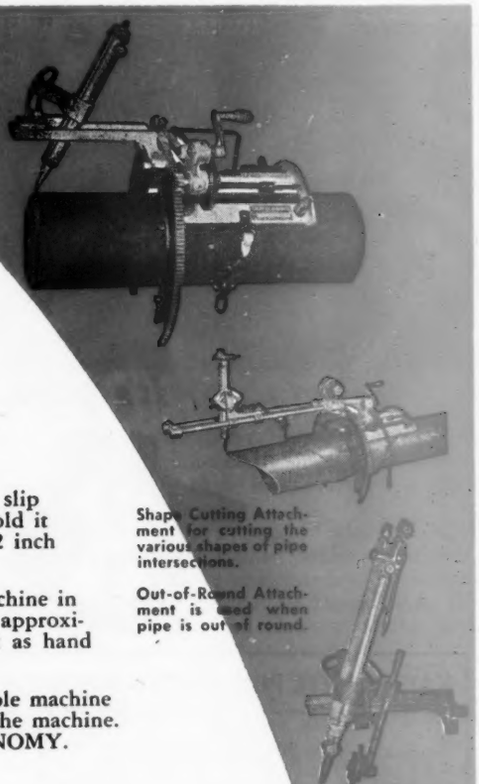
The executive committee has all of the authority with respect to the properties, funds, finances, and activities of AGA that is vested in the board of directors of the association. It functions during the intervals between the meetings of the full board.

Members appointed to the executive committee for the next association year are: Frank C. Smith, president, Houston Natural Gas Corporation, and president of AGA; Earl H. Eacker, president, Boston Consolidated Gas Company, and vice president, AGA; F. M. Banks, president, Southern California Gas Company, and vice president, AGA; Edward F. Barrett, president, Long Island Lighting Company, Mineola, Long Island, New York, and treasurer, AGA; Charles E. Bennett, president, The Manufacturers Light and Heat Company, Pittsburgh, past president of AGA; Lyle C. Harvey, president, Affiliated Gas Equipment, Inc., Cleveland, and treasurer, Gas Appliance Manufacturers Association; J. F. Merriam, president, Northern Natural Gas Company, Omaha; Dean H. Mitchell, president, Northern Indiana Public Service Co., Hammond, Indiana, and J. Theodore Wolfe, executive vice president, Consolidated Gas Electric Light and Power Company of Baltimore.

H&M

PIPE CUTTING AND BEVELING MACHINE

Cuts and Bevels Pipe FASTER, MORE ECONOMICALLY



Split horseshoe shaped gear permits machine to slip quickly over pipe. Fast operating snap chain fasteners hold it in place. A complete cut and bevel can be made in a 12 inch pipe in about two minutes.

You'll soon save several times the cost of the machine in labor, gas and transportation charges. H&M takes approximately one-half the labor and gas to make the cut as hand cutting and the work is all done in the field.

Bring this light (24 to 155 pounds) but durable machine to the pipe instead of moving the heavy pipe to the machine. Remember, H&M designs for SPEED and ECONOMY.

Shape Cutting Attachment for cutting the various shapes of pipe intersections.

Out-of-Round Attachment is used when pipe is out of round.

See for yourself. Let us arrange a demonstration.

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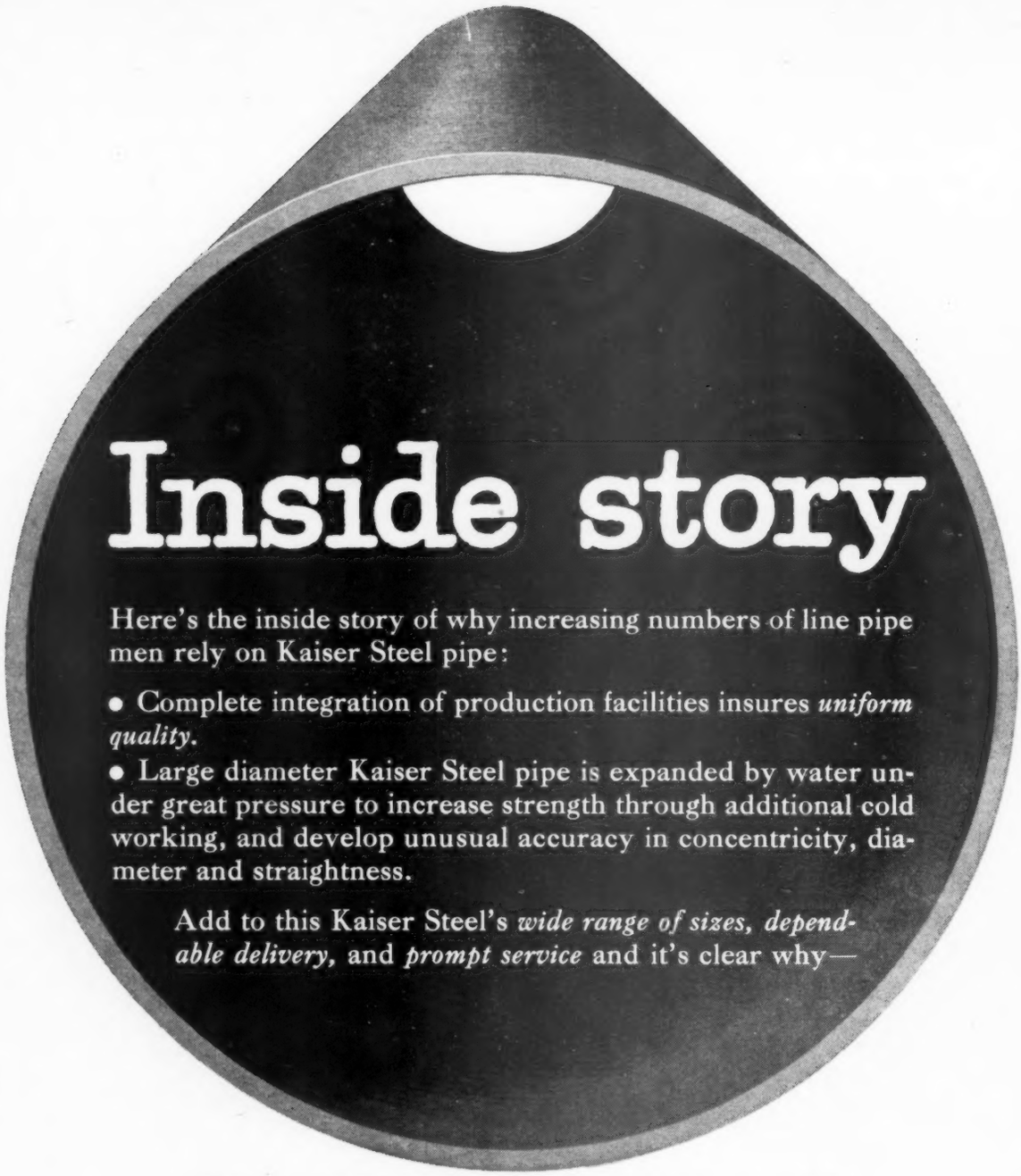

Inside story

Here's the inside story of why increasing numbers of line pipe men rely on Kaiser Steel pipe:

- Complete integration of production facilities insures *uniform quality.*
- Large diameter Kaiser Steel pipe is expanded by water under great pressure to increase strength through additional cold working, and develop unusual accuracy in concentricity, diameter and straightness.

Add to this Kaiser Steel's *wide range of sizes, dependable delivery,* and *prompt service* and it's clear why—

It's good business to do business with

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KAISER STEEL PIPE SPECIFICATIONS • All pipe manufactured to latest A.S.T.M. and A.P.I. specifications

Type	Diameter	Length	Wall Thickness	Shipping Point
Continuous Weld—Threaded and Coupled	½" to 4" nominal I.D.	Uniform 21'	Standard	Fontana, Calif.
Continuous Weld—Plain End	2⅜" to 4½" O.D.	Up to 40'	Standard	Fontana, Calif.
Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5 9/16" to 12¾" O.D.	Up to 55'	.188" to .375"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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Pipe Line Personals

W. L. Walker has been elected secretary of The Texas Pipe Line Company and Texas-New Mexico Pipe Line Company, it is announced by **J. W. Emison,** president. Walker entered the service of The Texas Pipe Line Company on January 21, 1920, as a stenographer-clerk and after serving in various assignments was elected assistant secretary on June 10, 1939.

B. E. Strode has been elected assistant secretary of The Texas Pipe Line Company and Texas-New Mexico Pipe Line Company. Strode entered the service of The Texas Pipe Line Company in 1922, as a clerk and served in the capacity of accountant and assistant to management.

J. E. Fairweather has been appointed safety engineer for the West Texas area by Shell Pipe Line Corporation. He has been serving as assistant area gaging inspector. Fairweather joined Shell in 1934 as an oiler at Hobbs, New Mexico, where he later became station engineer. He moved to Wasson, Texas, as station chief engineer in 1942 and to Monahans in the same capacity five years later. In 1950 he was transferred to Benedum as district foreman, then to Goldsmith the next year as district chief gager.

Jim Hinson, formerly a right-of-way agent with the Houston Land Department of Transcontinental Gas Pipe Line Corporation, has been made a safety engineer by the company. Before joining Transcontinental in December, 1950, he was variously with The Texas Company and Fish Constructors.

William R. Nelson, The Texas Pipe Line Company, Tulsa, is a new member of The Pipe Liners Club of Tulsa. Other recently admitted members are **Fred M. Daneke,** Cities Service Pipe Line Company, Bartlesville, Oklahoma; **H. D. Chrislip,** Deep Rock Oil Corporation, Tulsa, and **H. J. Chilton, Jr.,** Service Pipe Line Company, Tulsa.

E. L. Woody was recently promoted to chief operator of the Lordsburg turbine station by El Paso Natural Gas Company. He entered the employ of the company 20 years ago at Station No. 3 and later worked on construction and operations at Guadalupe and Lordsburg compressor stations.

J. G. Snow has been promoted to chief operator of the Benson turbine station. He has been with the company 13 years, and has worked at various stations on the system.

F. F. Fleming has been made chief operator of the Pecos River turbine station. Previously he had worked at El Paso station, Station No. 1, and in the home office purchasing department.

Neal Braswell has been promoted to chief operator of the Casa Grande turbine station. He has been with the company 15 years and since early in 1952 has been working at the station site on different phases of construction.

C. O. Bryan has been made chief operator of the Cornudus turbine station. He has been with the company since 1942 and has worked at El Paso, Gila, and Station No. 4.

Harrington Wimberly of Oklahoma has been reelected vice chairman of the Federal Power Commission for the calendar year 1953. Wimberly, who has been a member of FPC since October 5, 1945, served as vice chairman during 1952 and prior to that held the post during part of 1947 and all of 1948. Under provisions of the Federal Power Act, FPC each year selects one of its members to serve as vice chairman, who acts in case of the absence or disability of the chairman.

Transportation exhibits for the Hall of Science at the 1953 International Petroleum Exposition were outlined recently by a sub-committee. In planning session were: S. L. Westlake, assistant chief engineer, Magnolia Pipe Line; J. R. Polston, Service Pipe Line, chairman; C. C. Keane, Great Lakes Pipe Line. Back row, Ed E. Hurley, Service, K. T. Feldman and C. F. Mack, Sinclair Pipe Line; J. M. Bradley, Interstate Pipe Line; H. T. Chilton, Service; R. W. Phillips, Texas Empire and Kaw Pipe Line, C. I. Huss, Service.

P. K. Johnson

J. T. Noel

J. T. Osborn

Phil K. Johnson has been named superintendent of the tax, right-of-way and claims department for Platte Pipe Line Company, it has been announced by Millard K. Neptune, president of Platte. For the last four years, Johnson has been tax commissioner and budget director for the State of Nebraska.

Johnson is a native of Shubert, Nebraska, and received his higher education at the University of Nebraska where he majored in economics and public administration. During the war, he served in the Navy and attained the rank of lieutenant, senior grade.

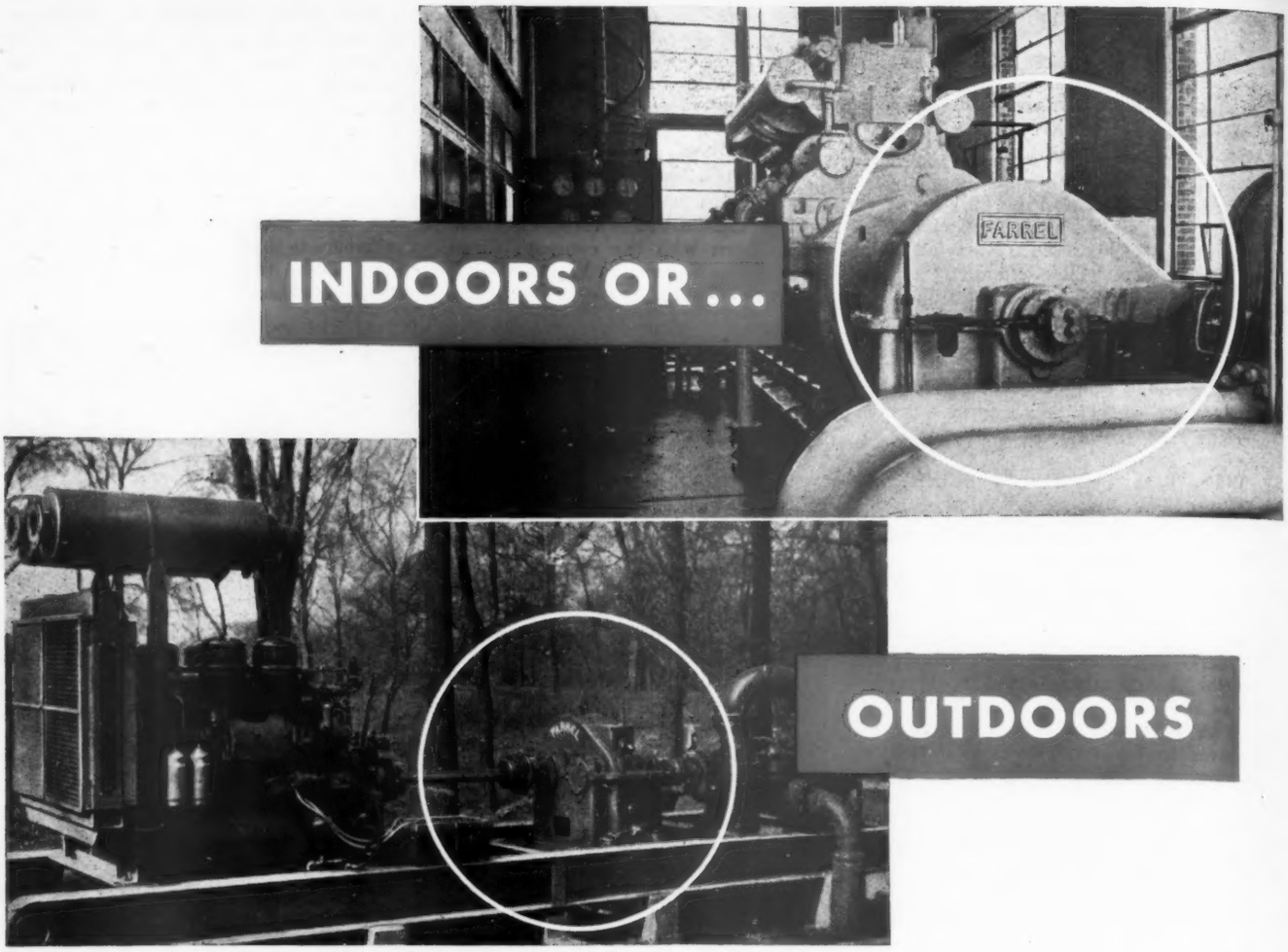
James T. Noel will head the accounting department, Platte Pipe Line Company, with the title of chief accountant, and **John T. Osborn** will direct the treasury department with the title of assistant treasurer. Both are formerly of Tulsa, Oklahoma, and in their new positions have their headquarters in Kansas City.

Noel is a graduate of Oklahoma A&M College, is a certified public accountant, and has been associated with Service Pipe Line Company, Deep Rock Oil Corporation, and Arthur Young and Company, public accountants.

Osborn also is a graduate of Oklahoma A&M College, with a degree in engineering. He took graduate work in business administration at Tulsa University. Prior to joining Platte, he had been associated with Service Pipe Line Company, Public Service Company of Oklahoma, and Continental Oil.

Platte Pipe Line Company is owned by British-American, Continental, Ohio, Pure, and Sinclair oil companies.

XUM



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PIPE LINE PROJECTS

Panhandle Eastern to Build Short Illinois Line

The Federal Power Commission has authorized Panhandle Eastern Pipe Line Company, of Kansas City, Missouri, to construct approximately 23 miles of natural gas pipe line and a 330-hp compressor station to augment the capacity of its Peoria, Illinois, lateral and other lines extending from it.

The project, estimated to cost $1,009,000, includes 13.2 miles of lateral loop line in Sangamon County and 10 miles of lateral line in the Lincoln, Illinois, area. The new compressor station is in Peoria County. Temporary authorization to construct and operate these facilities has already been granted by the commission.

FPC Examiner Favors Iowa Gas Pipe Line

Chief Presiding Examiner Frank A. Hampton of the Federal Power Commission has filed a decision, subject to review by the commission, issuing a certificate authorizing Iowa-Illinois Gas and Electric Company, of Davenport, Iowa, to construct 22 miles of natural gas pipe line and to continue the operation of other facilities, all in Iowa.

The proceedings involve two applications by the company, each requesting a disclaimer of jurisdiction over the facilities, or in the alternative, for a certificate authorizing their construction or continued operation. The first application (G-1899) was filed in connection with the continued operation of 23 miles of 4-in. duplicate transmission line serving the company's Ottumwa district in Iowa, and 17 miles of 10-in. duplicate line serving its Davenport district, also in Iowa. The other application involves the proposed construction of 22 miles of pipe connecting with Natural Gas Pipeline Company of America's system in Mahaska County, Iowa, and extending to a point in Ottumwa County.

Chief Examiner Hampton found that both the existing and proposed transmission facilities will be used in the transportation of natural gas in interstate commerce, subject to FPC jurisdiction, and are subject to the certificate provisions of the Natural Gas Act. He ruled that the facilities are not to be used for local distribution, as contended by the company.

Examiner Hampton's decision is subject to review by the Commission either upon appeal by parties to the proceedings within 20 days or upon the FPC's own motion within 10 days thereafter. If no review is initiated, the decision will become effective as the final decision and order of the Commission at the end of the 30-day period.

Transmission Line in Chicago Area Planned

Chicago District Pipeline Company, of Joliet, Illinois, has filed an application with the Federal Power Commission requesting authorization to construct approximately 35 miles of natural gas transmission line in the Chicago, Illinois, area to enlarge the capacity of its transportation system and to enable it to meet increasing requirements of existing customers.

Estimated cost of the project is $5,500,000, which would be financed through funds to be borrowed from Chicago District's parent company, The Peoples Gas Light and Coke Company. The proposed project also includes the abandonment of about 3.7 miles of existing lines.

The construction program would include about 3.4 miles of 36-in. pipe extending from a connection with a line to be built by Peoples Gas at a point on the Chicago city limits southwest to the east bank of the Des Plaines River; approximately 0.3 miles of 24-in. submerged pipe line across the Des Plaines River, and approximately 31.2 miles of 30-in. line extending from the west bank of the Des Plaines River to a connection with the company's existing system in Will County, Illinois.

Texas Eastern, Wilcox Trend Given Permits

The Federal Power Commission has authorized Texas Eastern Transmission Corporation, of Shreveport, Louisiana, and Wilcox Trend Gathering System, Inc., of Dallas, Texas, to construct pipe line facilities in Texas and Louisiana that will enable Texas Eastern to replace diminishing natural gas supplies in Louisiana.

Under the authorization, Wilcox will construct approximately 157 miles of pipe line extending from a point in the Hagist Ranch field in McMullen County, Texas, to a connection with Texas Eastern's system near Provident City, Texas. The project, estimated to cost approximately $10,500,000, also will include about 60 miles of laterals, a 2200-hp compressor station, and necessary metering and regulating facilities.

Texas Eastern was authorized to build a 315-mile pipe line extending from the Provident City connection with Wilcox's system to a point of connection with its existing system near Castor, Louisiana. Estimated cost of the Texas Eastern project is $23,283,540. The line will have a capacity of up to 140,000,000 cu ft a day and could be increased to 350,000,000 cu ft by the addition of compressor stations.

Texas Eastern will purchase approximately 100,000,000 cu ft of gas a day from Wilcox, for transportation with other gas purchased in the area through the proposed new line. The commission pointed out that gas supplies available to Texas Eastern in Louisiana are rapidly declining and will result in supply deficiencies increasing from 91,000,000 cu ft a day in 1953 to approximately 135,000,000 cu ft in 1956.

The FPC conditioned the Texas Eastern authorization to require that, in the event an order is issued denying that company authority to deliver gas to Algonquin Gas Transmission Corporation in New England, it file an application for a certificate authorizing the sale of the difference between its total system sales capacity and the total of the sales it is then authorized to make. The FPC previously had authorized Texas Eastern to deliver volumes of gas ranging from 125,000,000 cu ft a day in 1952-53 up to 220,000,000 cu ft in 1956-57 to Algonquin; however, that order has been set aside by a court ruling, and the case is now back before the FPC for further hearings.

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Kansas-Nebraska Gets Final Decision to Build

A decision by a Federal Power Commission Presiding Examiner authorizing Kansas-Nebraska Natural Gas Company, Inc., of Phillipsburg, Kansas, to abandon a 13-mile pipe line extending from the Minden area to Kearney in Nebraska, and to construct a new 10-mile line to serve 21 rural customers now served off the Minden-Kearney line, has become effective as the final decision and order of the FPC.

The 6⅝-in. Kearney-Minden line was built in 1930 to serve Kearney, but that city is now served by other facilities certified by the FPC. The only use now being made of the line is service to the rural customers, who will be served by the smaller 2-in., 10-mile line.

Phillips Plans Extension

Phillips Petroleum Company's wholly owned subsidiary, Phillips Pipe Line Company, plans to construct an extension of its West Texas crude oil gathering system to the Penwell field, Ector County.

The project, pending approval of PAD, will consist of 9 miles of 4-in. pipe line, which will connect the newly discovered Penwell-Waddill and Wrather (Fusselman) pools in the Penwell area to the company's Odessa-Borger crude oil pipe line. The new gathering line will also connect the Penwell-Ellenburger pool to the existing Phillips gathering system.

Texas-Ohio Decision Designated Tentative

The Federal Power Commission opinion and order issued last November 7, denying applications by Texas-Ohio Gas Company, of Houston, Texas, for authority to construct a 1406-mile pipe line and to import natural gas from Mexico, have been designated as a tentative instead of a final action.

Texas-Ohio and two interveners—the Public Utilities Commission of Ohio and Reserve Natural Gas Corporation—had asked for rehearing of the November 7 opinion and order and argued that the intermediate decision procedure had not been waived.

The commission pointed out that in its November 7 opinion it had referred to statements of counsel for Texas-Ohio to the effect that the company requested a final decision in the proceeding. The FPC said that it construed these statements to mean that counsel for the company waived the intermediate decision procedure.

The commission continued, "In order to remove all doubt that due process has been accorded and to meet the objections raised by these petitioners who now state that they have not waived the intermediate decision procedure, we shall accord them that procedure under all of the facts and circumstances." The commission noted that the Administrative Procedure Act provides that, in determining applications for initial licenses, such as the Texas-Ohio proceeding, the agency may issue a tentative decision.

Subsequent to the expiration of the 20-day period in which the parties may file exceptions to the tentative decision, the commission must issue a further order, e.g., adopting or modifying the tentative decision, which will become its final action in the proceeding.

Texas-Ohio is proposing to build a $185,000,000 pipe line extending from the U. S.-Mexican border in Hidalgo County, Texas, to a terminus near Lancaster, Ohio. Texas-Ohio planned to sell all of its gas to Reserve Natural, a newly formed corporation, at the Ohio terminus of the line.

In its November 7 opinion and order, the commission found that the company "has failed on this record to show that the proposed service, construction or operation is or will be required by the present or future public convenience and necessity."

Cities Service to Provide LP-Gas Storage Facilities

Establishment of an LP-gas storage terminal one mile west of Hutchinson, Kansas, is announced by Cities Service Oil Company.

The Cities Service terminal will include underground storage capacity of approximately 4,000,000 gal, some above-ground storage, and rail and truck loading and unloading facilities.

Underground storage will be washed out of the salt formation underlying the acreage just leased by Cities Service. Four shallow wells will be drilled. Fresh water will be circulated to dissolve and remove the salt. The brine water will be piped to the nearby Morton Salt Company plant for disposal. Each of the four caverns will have storage capacity of 1,000,000 gal of propane.

Propane will be shipped to the underground storage terminal from nearby gasoline plants by truck transport and from other Mid-Continent plants by rail tank cars. The product will be injected into the underground caverns during the summer months, when LP-gas is in light demand. During the peak-demand months of fall and winter, the stored product will be available to supply local Kansas demands. Shipments into other consuming areas will be by rail tank car.

Gulf Constructing Short Pipe Line in Texas

Gulf Oil Corporation, pipe line department, Houston, Texas, announces that the company is building a 22-mile, 8-in. crude oil pipe line from the Portilla field, Nueces County, into Corpus Christi, Texas.

The line will handle 10,000 to 12,000 bbl of oil a day and will terminate at the Pontiac refinery. Some of the oil will be taken at the refinery, some will be shipped by barge or tanker to other places.

It is expected that the line will be completed about April 1. Cost will run in excess of $300,000.

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With the PIPE LINE CONTRACTORS

Anderson Brothers Corporation, 6300 Navigation Boulevard, Houston, Texas, has contracted 80 miles of 24-in. for Texas Eastern Transmission Corporation, from Groveton to Waller, Texas. The field office is at Groveton with Dick Leonard superintendent and Al Fiege office manager.

For Lakehead Pipe Line Company, 190 miles of 30-in. has been contracted, but this work will not start until May or June. Claude Wilson will be project manager and Aldress Kilgore and Rusty Killingsworth spread superintendents.

Work progresses on the Rancho Pipe Line Company job, 267 miles of 24-in. between McCamey and Austin, Texas. Aldress Kilgore is superintendent, Russell McDowell office manager, and N. H. Zarafonetis paymaster.

Trojan Construction Company, Inc., 1416½ North Robinson, Oklahoma City, Oklahoma, began construction January 12 on 80 miles of 24-in. pipe line between Center, Texas, and Castor, Louisiana, for Texas Eastern Transmission Corporation. The expected completion date is April 15. The field office is at Center. Tex Maggard is spreadman, Vernon Yeager office manager, and Art Newbould purchasing agent.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa 3, Oklahoma, makes the following construction progress report as of January 14:

Aluminum Ore Company, Bauxite, Arkansas: Process piping, fabrication 98 per cent completed, and installation 90 per cent completed. Earl S. Powell is superintendent, Morris Carey office manager, and Ralph Bray, area superintendent.

Sinclair Pipe Line Company: Pump station, Quincy, Illinois, 90 per cent completed. Ray M. Johnson is superintendent and Fred Trompler office manager. Piping at Humboldt, Kansas. Pump Station, Pontiac, Illinois, 80 per cent completed. Charles Malone is superintendent and W. D. Kaufman office manager.

Panhandle Eastern Pipe Line Company: Fin-fan towers at Pleasant Hill, Illinois, 85 per cent completed. J. M. Graham is superintendent.

West Texas Gulf Pipe Line Company: Piping for pumping station at Ranger, Texas, 60 per cent completed. W. L. Daniel is superintendent and Lonnie Dorman office manager.

Reynolds Metals Reduction Plant, Gum Springs, Arkansas, receiving materials and equipment. Sub-contract from Aluminum Constructors Mechanical Trade. K. L. Kreamalmyer is superintendent.

O. R. Burden Construction Corporation, 6702 East 21st Street, Tulsa, Oklahoma, expects to complete in February the 600-miles of 6-in. through 14-in. take-up between Drumright, Oklahoma, and Humboldt, Kansas, for Sinclair Pipe Line Company. The spread having its headquarters at Wynona, Oklahoma, is working on 220 miles of 8- and 12-in. between the Arkansas River and Caney, Kansas. Paul E. Thibodeaux is superintendent and Guy Carder office manager. A second spread has its field office at Independence, Kansas, and is taking up about 191 miles of 8 and 12-in. between Caney and Humboldt. Ted Price is superintendent and John Freeman office manager.

Three spreads began work early in December on 186 miles of 12-in. products pipe line for Standard Oil Company (Indiana), the overall project extending from Sugar Creek, Missouri, to Dubuque, Iowa. Burden has the section from Unionville, Missouri, to Dubuque. One spread has its field headquarters at Ottumwa, Iowa, with Floyd Lewis superintendent and J. R. Purdy office manager. A second spread is working out of Iowa City, Iowa, where R. C. Wilkerson is superintendent and J. B. Thomas office manager. The third spread is at Anamosa, Iowa. Al Perry is superintendent and Bill Robinson is office manager.

Vaughn and Taylor Construction Company, P. O. Box 1351, Wichita Falls, Texas, kicked off early in January on 40 miles of 16-in. pipe line from Pan-American Pipe Line Company between Arden and Eldorado, Texas. The field office is at the latter point. D. D. Vaughn is superintendent and W. W. Teer office manager.

Engineers Limited Pipeline Company, 225 Bush Street, San Francisco, California, is engaged in laying 84 miles of 34-in. loops to the main line of Pacific Gas and Electric Company between Topock, Arizona, and Milpitas, California. The job got underway the middle of January. Field headquarters are at Bakersfield, California. Louis Robertson is superintendent and Bob Wiley office manager.

H. B. Zachry Company, P. O. Box 2570, San Antonio, Texas, has contracted and is underway on 140 miles of 8-in. through 16-in. for the Wilcox Trend Gathering System. A field office has been opened at Yoakum, Texas, with D. D. Shrum superintendent and Ray Shields office manager.

Panama-Williams Company, 1417 Melrose Building, Houston, Texas, is laying 86 miles of 26-in. pipe on the West Texas Gulf Pipe Line Company system. The section is from Livingston to Beaumont, Texas. The spread in charge of Gene Coulter is making its field headquarters at Sour Lake. C. H. Sisco is his assistant and Ernest Smith office manager. At Beaumont, M. E. "Panama" Shiflett is in charge with Cooney Shiflett, M. B. Henderson, and Paul Wright assistant superintendents. The office manager is Lloyd Evans.

Houston Contracting Company, Ltd., 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Approximately 190 miles of 24-in. crude oil line for Rancho Pipe Line Company from Pasadena, Texas, west to Cedar Valley, approximately 20 miles west of Austin. E. C. Norris is superintendent, R. E. Thornton assistant superintendent, R. J. Axsom, field office manager. Headquarters are at Bastrop, Texas. Approximately 125 miles completed January 9.

Approximately 34 miles of 6-in. butane line for The Texas Pipe Line Company from Sour Lake, Texas, to Port Arthur, Texas. F. A. Silar is superintendent, L. F. Redfearn field office manager. Headquarters, Sour Lake, Texas. Began laying pipe January 12.

Approximately 40 miles of 16-in. natural gas line for Houston Pipe Line Company from vicinity of Edna, Texas, to the Tom O'Connor gas field. Headquarters to be Edna, Texas. Pipe to arrive early in February. Work to be done by F. A. Silar's spread. Other plans to be announced later.

Approximately 525 miles of 24-in., 20-in., 16-in., and 14-in. natural gas lines for Southern Natural Gas Company in Georgia, Mississippi, and Louisiana. Work to start about March. Personnel and locations to be announced later.

Williams Brothers de Venezuela, S.A., Maracaibo, Venezuela, is laying 170 miles of 26-in. pipe line for Creole Petroleum Corporation from Ule station on the east side of Lake Maracaibo to Amuay Bay. Marvin Jones is superintendent.

Ray L. Smith and Son, Inc., Hazlett Building, El Dorado, Kansas, have completed, except for a metering station, approximately 20 miles of 12, 20, 24, and 30-in. pipe line for Natural Gas Storage Company between Dwight and Herscher, Illinois. The station should be completed by February 15. In charge of the work have been Dewey Whitworth superintendent, D. L. Marley office manager, W. B. Wakefield welding foreman and Guy O. Whitworth, clean-up foreman.

Engineering-Construction Company, 402 North Cheyenne Street, Tulsa, Oklahoma, has just completed two jobs. A city distribution system was installed at Paragould, Arkansas, for the Mid-South Gas Company. Curt Vaughan, vice president of the company, supervised the project, with James W. Tyner office manager and W. H. Jones spread foreman. For Colorado Interstate Gas Company, a gathering system was laid near Lakin, Kansas, consisting of pipe 4 in. through 12 in. Lee Vaughan, president, supervised this project. Earl Hackleman was spreadman and V. L. Bethel office manager.

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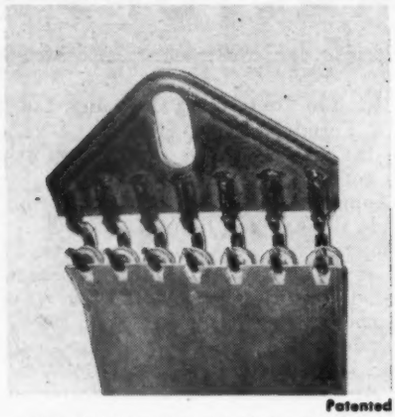

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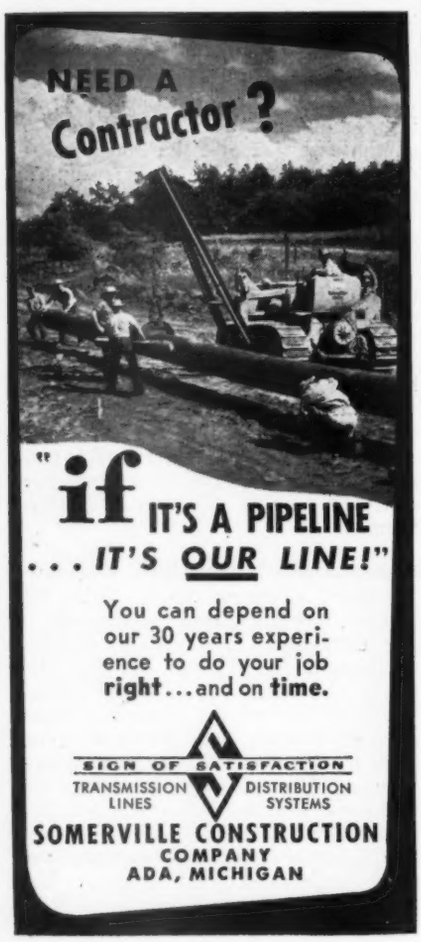
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Pipe Line Contractors

▸ **H. C. Price Co., Pipeline Division,** P. O. Box 1111, Bartlesville, Oklahoma, has the general contract covering construction of approximately 363 miles of 26-in. high pressure natural gas loop lines for Texas Gas Transmission Corporation from east bank of Mississippi River near Greenville, Mississippi, to Jeffersontown Station, Kentucky, a few miles east of Louisville, 42 miles remaining to be completed as of January 14.

Also the general contract covering construction of approximately 200.4 miles of loop and new lines for Southern Natural Gas Company in Mississippi, Alabama, and Georgia; 16.6 miles of loop lines completed in 1952.

All work has been shut down until spring. Winter headquarters for spreads are as follows:

Spread One, Princeton, Kentucky, General Delivery, Telephone 2083: G. A. Reutzel, superintendent; W. E. Yount, office manager; J. H. Ingram, equipment foreman; K. N. Adkins, road crossing; J. A. Hairston, right-of-way; Lloyd J. Loncarich, ditch; H. C. Morrison, pipe; J. C. Anderson, bending; R. W. Orr, welding; S. J. Wood, coating; Athel Bell, lower-in, and T. E. Walker, cleanup.

Spread Two, St. Mathews, Kentucky, General Delivery, Telephone Taylor 6140 (Louisville): R. L. Ezell, superintendent; W. R. Crego, office manager; Tommy Stammer, equipment foreman; Cleo Robertson, road crossing; J. D. White, right-of-way; W. H. Olrich, ditch; J. H. Latham, bending; Delbert Shivel, pipe; J. H. Riley, welding; J. B. Northcutt, coating; C. W. Sisco, lower-in, and S. L. Price, cleanup.

Spread Three, Halls, Tennessee, General Delivery, Telephone 6321: C. E. Shivel, superintendent; D. H. Johnston, office manager; Boyd Danner, equipment foreman; C. F. Jones, right-of-way; R. H. Edwards, right-of-way; Ray Drewell, ditch; R. E. Carriker, pipe; John Stokes, welding; Henry Hill, coating; Bill Buchanan, lower-in, and Paul McCormick, cleanup.

Spread Four, Oxford, Alabama, General Delivery, Telephone 257: C. R. Ice, superintendent; G. A. Harvey, office manager; Jesse Cash and W. O. Elliott, right-of-way foremen; E. W. Whisenant, ditch; Forest Loinette, bending; W. T. Dickerson, pipe; L. O. Reutzel, welding; N. D. Adams, coating; J. C. Rich, lower-in, and J. E. Hamilton, cleanup.

▸ **Modern Welding Company,** Owensboro, Kentucky, is installing a complete natural gas transmission line and distribution system for the city of Fort Valley, Georgia. Other contracts now in progress are for Tullahoma Natural Gas Company, Tullahoma, Tennessee; City of Lawrenceburg, Tennessee; Owensboro-Ashland Oil Company addition, and Western Kentucky Gas Company additions.

▸ **Associated Pipe Line Contractors, Inc.,** 3272 Westheimer Road, Houston, Texas, began work in January on approximately 65 miles of 20-in. pipe line for Cities Service Pipe Line Company between Sour Lake, Texas, and Sulphur, Louisiana. The field office is at Sulphur with Willie Briley superintendent and James Luther office manager.

Work continues on 106 miles of take-up between Erath and Lake Charles, Louisiana, for The Texas Pipe Line Company. The field office is at Lake Arthur with Jim Andrews superintendent and J. B. Robbins and Ralph Herwig office managers.

Between Waller and Provident City, Texas, 80 miles of 24-in. will be laid for the Texas Eastern Transmission Corporation. The main field office is at Columbus with a warehouse at Eagle Lake. Jim Andrews is in charge.

▸ **H. C. Price Co., Somastic Division,** Box 1111, Bartlesville, Oklahoma, has the following jobs in progress:

East Coast Division, Bustleton, Pennsylvania:

Philadelphia Gas Works Company—Application of Somastic coating to 62,476 ft of pipe ranging in size from 6 to 30 in.

Gulf Oil Corporation—Application of Somastic coating to 52,135 ft of pipe ranging in size from 6 to 24 in. Application of Hevicote to 9300 ft of 8, 12, and 16-in. pipe.

Okonite-Callender Cable Company—Application of Somastic coating to 16,695 ft of 4 and 6-in. pipe.

Phelps Dodge Corporation—Application of Somastic coating to 12,000 ft of 5-in. pipe.

Buckeye Pipe Line Company—Application of Somastic coating to 8475 ft of pipe ranging in size from 8 to 14 in. Application of Hevicote to 3475 ft of pipe ranging in size from 8 to 14 in.

Gulf Coast Division, Harvey, Louisiana:

L. E. Farley, Inc. (For Interstate Natural Gas Company, Inc.)—Application of 9/16-in. of Somastic and 1⅝-in. Hevicote to approximately 30 miles of 16-in. pipe.

▸ **Mary Construction Company,** Cape Girardeau, Missouri, laying 180 miles of 8-in. products pipe line for the Indiana Farm Bureau Cooperative Association, from Mt. Vernon to Jolietville, Indiana, has moved its headquarters to Bicknell, Indiana. Garland Mims is superintendent and Lewis Wiist office manager.

▸ **L. E. Farley, Inc.,** 2609 Sunset Boulevard, Houston, Texas, has contracted 64 miles of 16-in. pipe line from Interstate Oil Pipe Line Company, to be laid from Morgan City to Baton Rouge, Louisiana. The field office is at Plaquemine with Doc Berton superintendent, Ernest Tyrney spreadman, and Fred Hudson office manager.

▸ **George W. Tucker Pipe Line Construction Company,** Odessa, Texas, has under construction 30 miles of 18-in. pipe line from Wink to Goldsmith, Texas, for the West Texas Gulf Pipe Line Company. The job began in January. The spread is working from Odessa. R. E. Pigg is superintendent and C. P. Brownell office manager.

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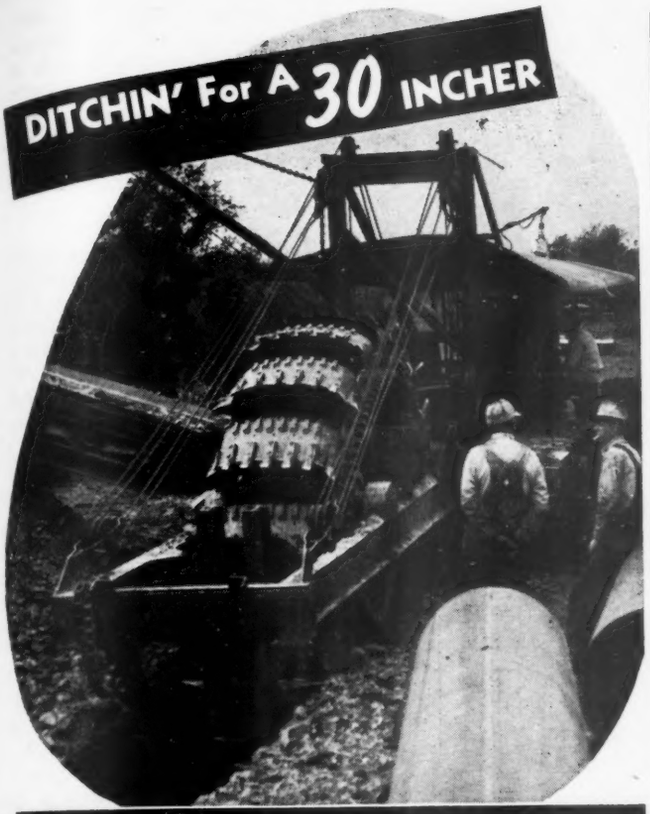

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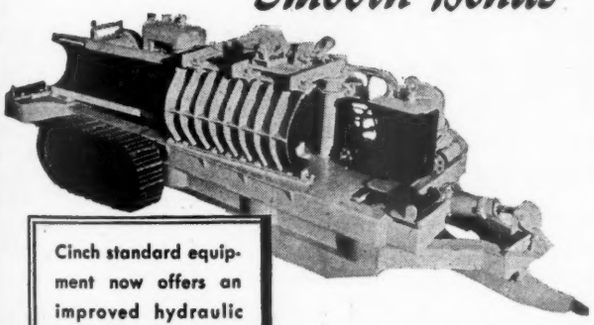

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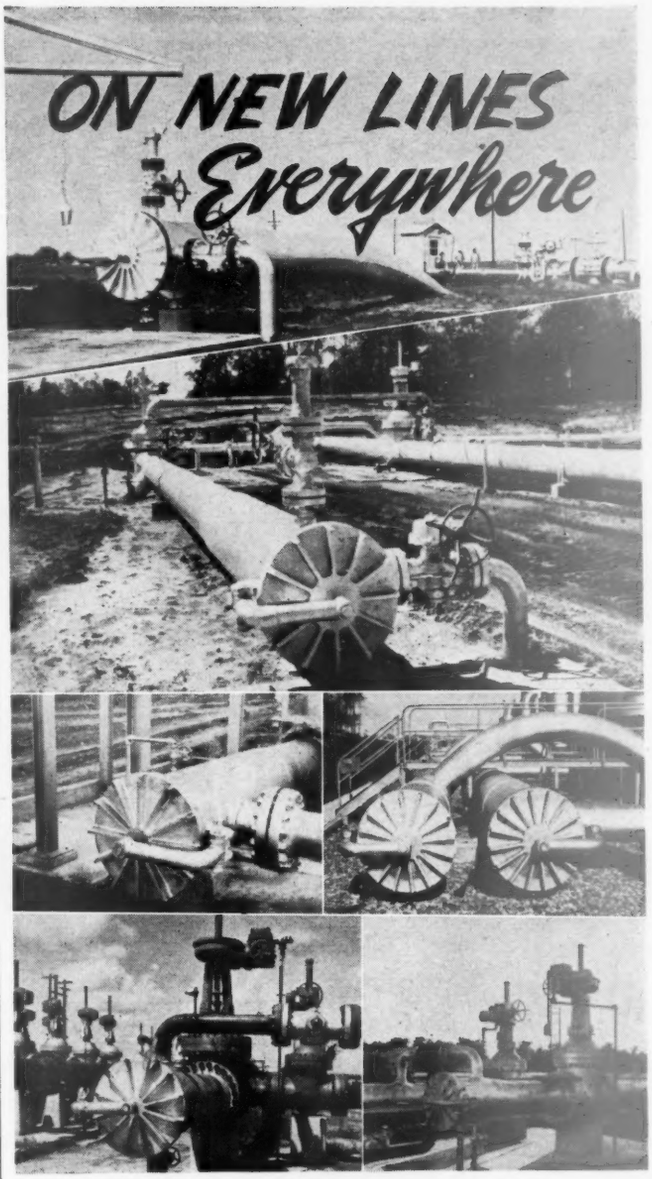

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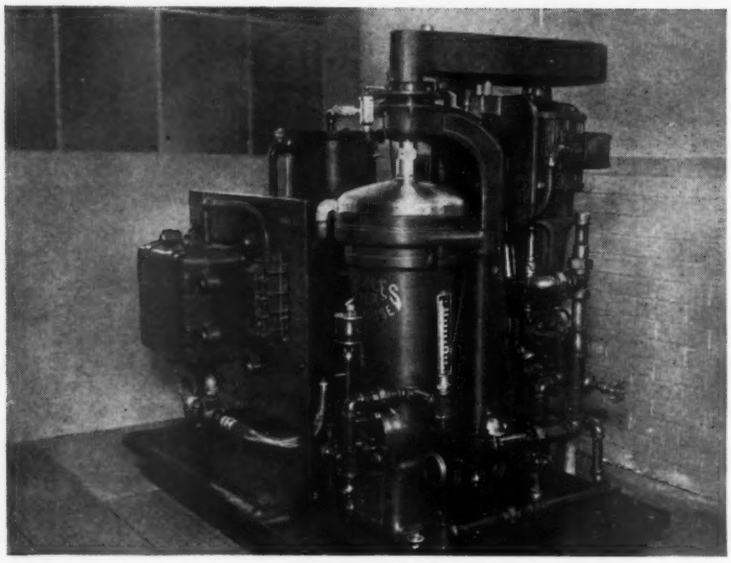

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Pipe Line Contractors

Rumsey Brothers Pipe Line Construction Company, 4039 North Broadway, Wichita, Kansas, began work in January on 45 miles of 12-in. between Pasadena, Texas, and the Trinity River for Sinclair Pipe Line Company. The field office is at Channelview. Myrl Rumsey is superintendent and Glen Stitt office manager.

Brown and Root, 4100 Clinton Drive, Houston, Texas, got underway late in December on 27 miles of 26-in. for Pan American Pipe Line Company between Genoa and Texas City, Texas. Field headquarters are at League City. J. W. Kincy is spread foreman, Bob Bruflat office manager, and Coy Spears foreman of welders.

Morrison Constructors, P. O. Box 3206, Austin, Texas, has begun the laying of 43 miles of 26-in. pipe between Falfurrias and Edinburg, Texas, for the Texas Eastern Transmission Corporation. Field headquarters have been established at Edinburg, with Emmett Wilkerson the superintendent.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, is laying in Kansas and Nebraska about 100 miles of 26-in. loops for the Northern Natural Gas Company. The field office is at Beatrice, Nebraska, with A. A. Carrigan superintendent and Dave Wagner office manager.

Between Merino, Colorado, and Gurley, Nebraska, 112 miles of 4-in. through 12-in. pipe is being laid for the Toronto Pipe Line Company. Field headquarters are at Sterling, Colorado. Oscar Phillips is superintendent and Jerry Short office manager.

R. E. Pitts Contracting Company, Clarksville, Arkansas, is constructing approximately 100 miles of city and plant work for the MidSouth Gas Company, pipe ranging in size from 1 in. through 8 in. Ralph Pitts is general superintendent and Tex Glover assistant.

Mannix, Ltd., 332 Seventh Avenue West, Calgary, Alberta, Canada, is laying the 224 miles of 24-in. from Blue River to Coquihalla Pass, British Columbia, on the Trans Mountain Oil Pipe Line Company system. The field office is at 412 Victoria Street, Kamloops, British Columbia. C. P. Baker is project manager.

N. A. Saigh Company, Inc., Suite 531 Majestic Building, San Antonio, Texas, has contracted to lay 75 miles of 24-in. pipe for the Texas Eastern Transmission Corporation, from Provident City to Hempstead, Texas. Location of the field office and key personnel will be announced later.

Sparling-Davis Company, Ltd., 7310 99th Street, Edmonton, Alberta, Canada, is installing a 24-in. river crossing near Kamloops, British Columbia, for Trans Mountain Oil Pipe Line Company, subcontracted from Mannix, Ltd. D. R. Hibbs is dredge superintendent and Cliff Poole construction superintendent.

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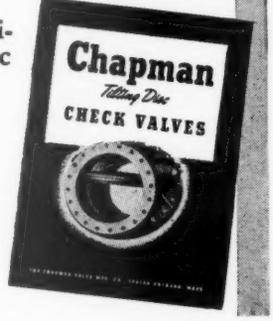
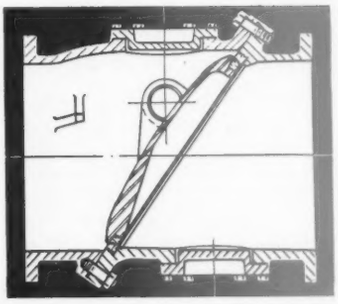
Exclusive TILTING DISC *Check Valve*

Nothing can "unseat" the disc-ring of this valve from its *drop-tight* contact with the body-ring . . . because clearance at the hinge-pins means that this contact is *complete.* There is no sliding action, consequently no wear, no leakage. And the pivoted disc is cushioned to an easy, silent closing . . . without slam . . . in installations that don't have unusual piping arrangements.

What's more, hydraulic laboratory tests at a top engineering school prove that the specially designed disc and streamlined valve-body reduce head loss as much as 80% under conventional swing-type check valves. See the graphs of these tests . . . and illustrations of the unique construction features of Chapman Tilting Disc Check Valves . . . in Catalog No. 30 (yours for the asking). *Write.*



THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASSACHUSETTS



Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

High Import Rate Is Fought by Independents

A fight to cut foreign oil imports has been going on for some time and from appearances will continue for some time this year. From various agencies in different parts of the country have come complaints about the high rate of oil imports, over the 1,000,000 bbl per day mark since October, and attempts have been made to force a cut back.

Russell B. Brown, general counsel of the Independent Petroleum Association of America, speaking at a district meeting in Houston, Texas, warned that foreign operating oil companies "have become powerful" and added that "their influence on our Government is great."

Texas independents, claiming the situation is out of balance, are waging a campaign to capture some of the foreign market. Allowable flow of Texas oil has been cut from an all-time high of 3,387,245 bbl per day November 29 to 3,228,937 in February of this year, and members of the Texas Independent Producers and Royalty Owners Association, have demanded to know why this situation exists.

From the Interior Department a report has warned the National Security Resources Board to go slow on imports. Approved by Oscar L. Chapman, former secretary, the report said "Heavy Reliance on one single source of foreign supply may carry with it dangers of monopolistic price behavior at a future date. Reliance on oil supplies from a distance carries grave security dangers," the report added.

PAD Allots 17,062 Tons of Drill Pipe in 2nd Quarter

A total of 17,062 tons of drill pipe has been allocated to 366 oil and gas operators for the second quarter of 1953, the Petroleum Administration for Defense has announced. PAD received 402 applications for authorizations of drill-pipe purchases during the quarter. Thirty-six of these were denied either because the operator had a sufficient inventory or because he filed his application after the deadline.

Operators May Make Foreign Materials Trades

General authorization for oil and gas operators to make trades or exchanges of new oil-country tubular goods and line pipe involving foreign-made goods under certain conditions has been granted by the National Production Authority at the request of the Petroleum Administration for Defense.

While such trades or exchanges have been permitted in the past, they have required prior specific PAD approval for each transaction. The extension of general authorization was accomplished through amendment of Direction 7 to NPA Order M-46 and Direction 5 to NPA Order M-46A.

Order M-46 sets out the priorities-assistance system for oil and gas operators in the United States and Canada, while Order M-46A sets out this system for the foreign petroleum industry.

Texas to Spend $1 Billion for Oil Expansion in 1953

Expansion for defense purposes by the Texas petroleum industry soared during 1952 as various segments of the industry earmarked nearly $1 billion for growth.

Based on certificates of necessity granted by the Defense Production Administration and tabulated by the Texas Mid-Continent Oil and Gas Association, some $900,000,000 were slated during the first 11 months of the year for increasing oil and gas processing, manufacturing, and transportation facilities.

Association statisticians pointed out that the figure does not account for non-certificate outlays of funds by petroleum industry firms.

Pulling into the lead at year's end was the state's giant petro-chemical industry with $320,000,000 tabbed for 82 expanded facilities. Following was pipe line construction with $312,000,000 for 53 projects.

Of the other major categories of the industry, excepting production:

Refineries, $139,000,000 for 124 projects; and field processing, $111,000,000 for a state-wide expansion program.

Fourth-quarter certificates granted Du Pont boosted the chemical figure. Du Pont will spend over $33,000,000 on its Victoria plant and nearly $4,500,000 on its Orange facilities.

In refinery growth for the period, Gulf Oil Corporation slated over $12,000,000 in defense expenditures at its Port Arthur refinery. Humble Oil and Refining will spend more than $5,000,000 at its Baytown facilities, and Phillips Petroleum will put $7,000,000 in an expanded Sweeney plant.

Cities Service Oil Company will add new facilities in Crockett County at a cost of over $2,000,000 for extracting and processing natural gasoline. This and other field processing expansions accounted for an 11-month total of 77 projects either completed or under way.

Total Imports Stay at Rate Of 1,000,000 Bbl Per Day

Total imports of oil into the U. S. was still above the 1,000,000 bbl per day mark at the end of the week, January 10, the American Petroleum Institute reported.

Average imports were placed at 1,304,600 bbl per day compared with 1,103,200 bbl per day January 3.

Week ended	Crude oil	Residual oil	Others	Total
Dec. 13	712,300	507,000	19,700	1,239,000
Dec. 20	586,500	405,400	14,000	1,006,900
Dec. 27	581,000	431,800	14,700	1,027,500
Jan. 3	487,400	607,200	8,600	1,103,200
Jan. 10	730,000	557,200	17,400	1,304,600

Below are exports for the week ending November 21, 28, December 5, and 12, as reported by the Petroleum Administration for Defense. Figures are given in thousands of barrels daily.

	Avgas.	Motor Gasoline	Kerosine	Distillate	Residual	Total
Nov. 21	34.1	47.4		85.2	43.7	210.4
Nov. 28	67.0	45.4	16.5	44.9	50.2	224.0
Dec. 5	28.2	62.2	11.9	99.1	26.5	227.9
Dec. 12	31.9	41.7		74.2	39.4	187.2
4 weeks ended Dec. 12	40.3	49.2	7.1	77.7	41.0	215.3

Crude Stocks Rise

Total crude stocks in the U. S. for the week ending January 10 were under that of the week before, despite a jump in foreign stocks, the U. S. Bureau of Mines has reported. A total of 267,878,000 bbl of crude oil was reported, 402,000 bbl under January 3 weekend.

Compared with January 12, 1952, inventories were up 5.6 per cent, a total of 14,262,000 bbl.

Foreign crude stocks were up 815,000 bbl after a week of high imports, making it the largest source of increases. Only other large gains were 813,000 bbl of Texas Gulf Coast oil.

Compared with a year earlier, gasoline stocks were up 1.6 per cent; kerosine stocks 1.8 per cent; light fuel oil stocks 16.6 per cent.

More Crude Producing In Texas This Month

Texas is producing slightly more oil this month than last. The Texas Railroad Commission set the state's permissible output at 3,228,937 bbl per day, 10,396 bbl a day over the January allowable. A cut in the calendar days production schedule was set by the Commission, with Texas fields in general producing 20 days, and East Texas field operating 17 days.

Magnolia Petroleum Company reported it would withdraw 12,000 bbl of crude oil daily from storage even with the rate of increase, and Shell Oil said it would withdraw 5000 bbl a day.

The Bureau of Mines has predicted that demand for Texas crude this month would be 10,000 bbl daily less than the month ago forecast. Chairman Ernest O. Thompson of the Texas Railroad Commission said the Bureau's estimate is 2,880,000 bbl daily, down 348,541 bbl daily below current producing quotas.

D & D Annual Meet Date Set

Desk and Derrick National Convention dates have been set for September 10-11, in Denver, Colorado. Minetta Miller, Sioux Oil Company, Suite 220, Paramount Building, Denver, has been appointed by the Association Board to serve as general arrangements chairman.

New Credit Card Plan

A new executive-industrial plan has been announced by the Diners' Club. The plan affords one or 50 members of a company nation-wide credit cards that are honored at various restaurants and hotels. The Diners' Club "E-I" member may have dinner, including liquor, sign the check, and at the end of the month the bookkeeper receives one invoice.

The new plan costs a company $5 annual membership fee. Sample Diners' Club Executive-Industrial Credit Book listing facilities, restaurants, and application card will be sent on request.

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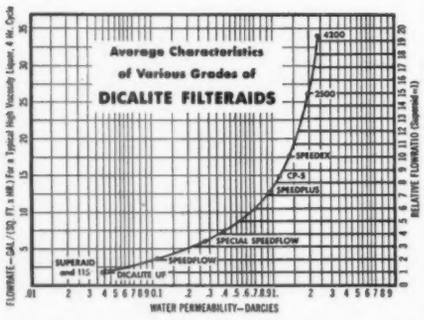

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News

West Coast Oil Men Fail To Get Price Rise on Crude

The Office of Price Stabilization has failed to give approval for higher ceiling prices on West Coast crude, despite a demand for higher prices from Standard Oil Company of California and Union Oil Company officials. OPS emphasized, however, that the request did not meet its standards, and added that other Government agencies such as the Petroleum Administration for Defense, Economic Stabilization Agency, Defense Department, and others may want to meet further on the request.

PAD had told OPS late last year that a price increase for the western companies would encourage production. The two companies had asked for price rises because of petroleum shortages on the coast. They claimed that demands for oil from the military, added to higher civilian demand, had forced them to bring in crude oil from other regions.

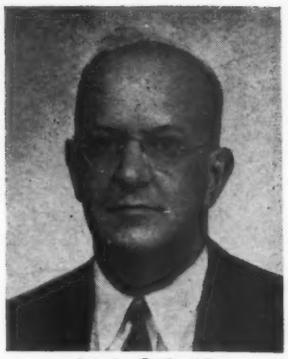
Western producers received more bad news about the same time, when they were told that PAD had turned down a request for more oil country tubular goods during 1953. J. Ed Warren, deputy PAD administrator, refused the request in a letter to D. T. Staples, president of the Oil Producers Agency of California, and added that he recognized the shortage of petroleum in California but did not believe increased allocations of tubular goods to the area would solve the problem. Warren also wrote that he believed "one of the impediments to adequate supplies in California is a matter of economics."

French Oil Technicians Study U. S. Methods

Under the sponsorship of the Mutual Security Agency, six French Nationals arrived in Bartlesville, Oklahoma, recently to begin a six-months' training period in petroleum technology. They are Jean Curutchet, Henri Tachet des Combes, Marcel Masson, Andre Narbonne, Maurice Ozil, and Jean Le Chatelier.

The first four named young men are now at the Petroleum Experiment Station of the Bureau of Mines for a two-weeks' indoctrination. Ozil and Le Chatelier, who are interested mainly in refining operations, reported immediately to Cities Service Oil Company and have gone to their first assignment at the company's refinery at Ponca City, Oklahoma. Later they will spend some time at the company's East Chicago refinery.

Masson and Narbonne will study drilling and production methods under the sponsorship of Phillips Petroleum Company. Curutchet, who is a staff member of the French Petroleum Institute in Paris, and Tachet des Combes, who is a petroleum engineer for a French Morocco oil company, will spend most of their time at the Experiment Station studying methods of research pertaining to reservoir fluids in high-pressure fields, the extraction of oil by secondary-recovery methods, and other related research now in progress.



N. A. C. Smith

Bureau of Mines Award Conferred Posthumously

The Department of the Interior has conferred posthumously its highest award for distinguished service in the name of Nicholas A. C. Smith, who for 19 years was superintendent of the Petroleum Experiment Station of the Bureau of Mines in Bartlesville, Oklahoma, and served the Government almost 37 years before his death on May 19, 1952. The citation was originally read by the Secretary of the Interior at the Tenth Honor Awards Convocation of the United States Department of the Interior in Washington, D. C., on December 16.

The citation points out that N. A. C. Smith was a pioneer in developing methods of analytical distillation of petroleum and its products, and in interpreting crude oil analyses, and that he added greatly to the fund of human knowledge in chemisty of petroleum.

Oil Storage Capacity Up

The National Petroleum Council finds that the oil industry must maintain approximately 100 bbl of petroleum storage to every 50 bbl of actual inventory (oil held in storage) according to a recent study released by Walter S. Hallanan, Chairman of the Council.

Significant facts noted from the survey are that the industry's capacity to store and handle crude oil and refined products has increased greatly in the last four years, particularly in the clean products group, for which large additional growth is recorded during the last three quarters of 1952.

Total capacity for storage of crude oil in tanks above ground in the country as a whole amounted to 429,400,000 bbl on March 31. Total crude oil in tanks and pipe lines, tankers, etc., was 238,400,000 bbl. The amount in tanks alone was 192,700,000—indicating above ground tanks were 44.9 per cent full.

In connection with storage Skelly Oil Company has announced that it has begun drilling operations at a test in Western McPherson County, Kansas, which will be used as a salt brine disposal well. A large salt bed storage facility for liquid petroleum gas will be estabished on the 48-acre tract in McPherson County. Skelly officials reported the test will be drilled to the Arbuckle lime for completion and when the salt bed storage tanks 400 ft below the surface are washed out the brine will be pumped into the deep well for disposal.

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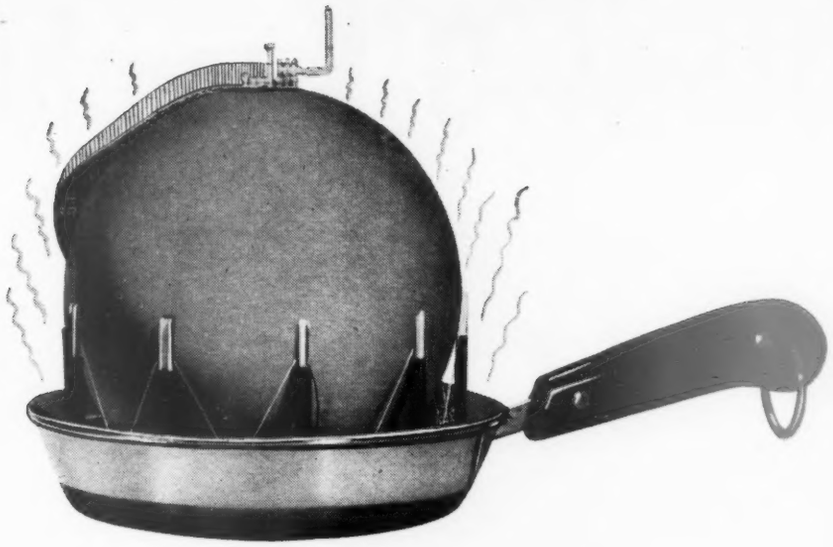

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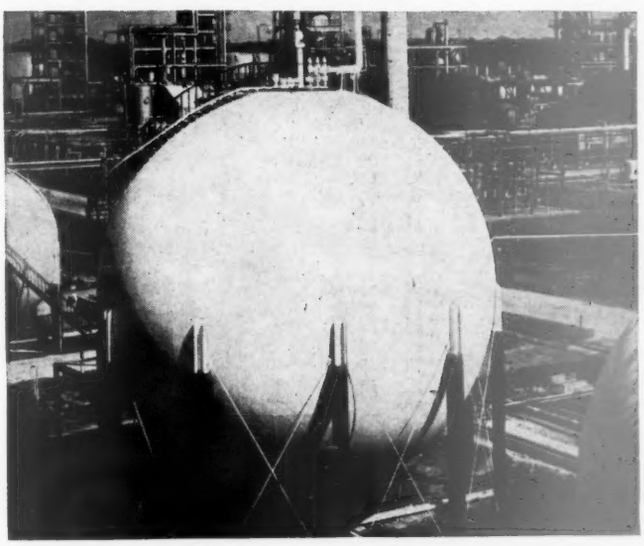
For further information, consult your nearest Du Pont Sales Technician, or write: E. I. du Pont de Nemours & Co. (Inc.), Finishes Division, Wilmington 98, Delaware.



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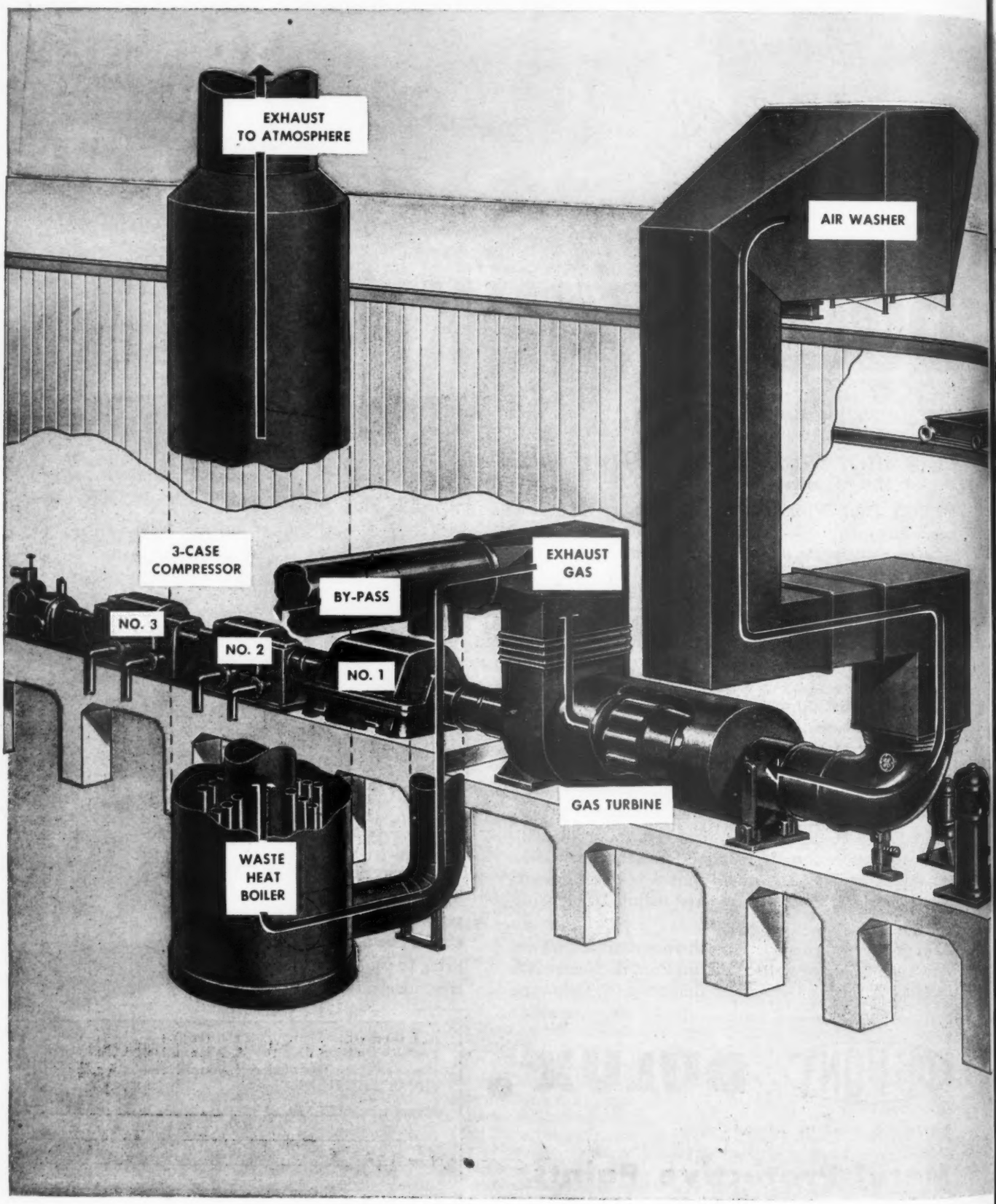
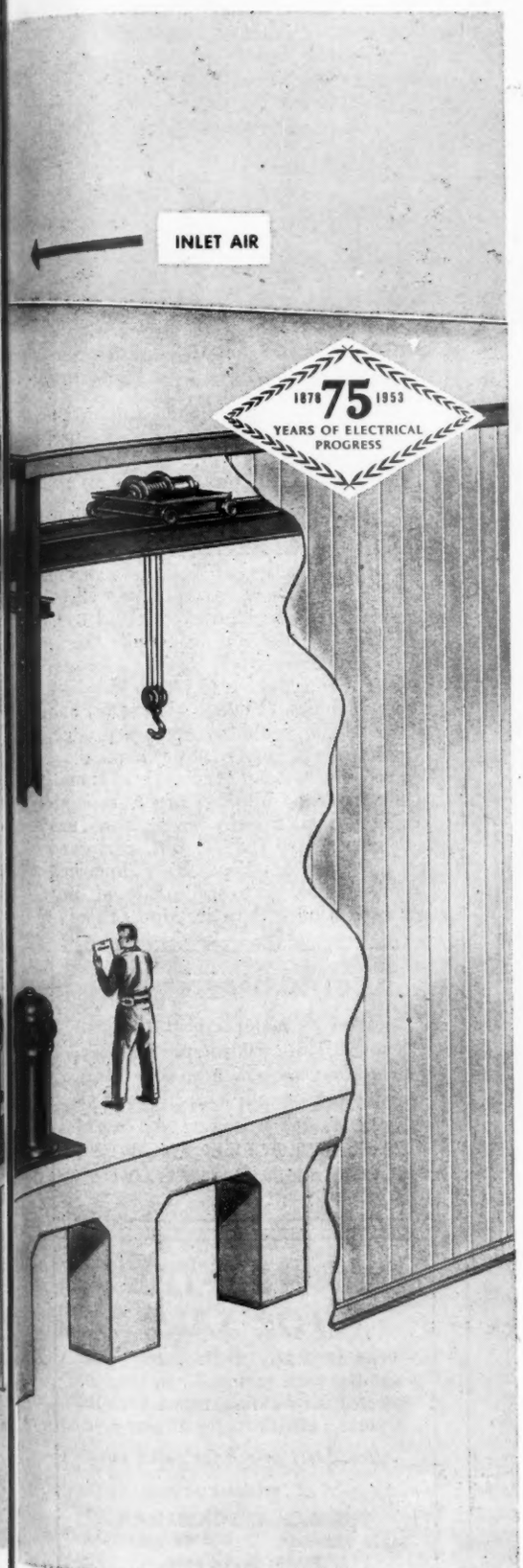


turbine for process plants



Reliable prime mover improves heat balance without need for extra steam-plant investment

Here is another application for General Electric's 5000-hp combustion gas turbine—of interest especially to refineries, petrochemical and other process plants that require considerable amounts of low-pressure steam. In many applications, it is the most economical over-all method of driving large centrifugal compressors.

Lower installed cost

If your plant requires more low-pressure steam—for an added new process or the expansion of present processing—you would ordinarily have to build additional steam-boiler facilities to maintain an efficient heat balance. Using the G-E gas turbine and a waste-heat boiler instead, you receive both needed steam and driving power, improve your plant's heat balance, and eliminate the need to invest in an extra steam plant.

Simplified building construction

For the horsepower it makes available, the building to house the G-E gas turbine is small, simple and inexpensively constructed. Foundations cost less because the turbines and the compressors they drive are relatively small and light in weight. Less manpower is required than with other types of drives, for this G-E prime mover is essentially automatic in operation—even lends itself to remote operation. With only two main rotating parts, upkeep costs are low, and maintenance is mostly a matter of periodic inspection.

Backed by G-E turbine leadership

More than 45 years of turbine-engineering leadership stand back of the G-E combustion gas turbine and assure its operating reliability. Your G-E Apparatus Sales representative will gladly discuss its application to your operation. Meanwhile, send for descriptive 16-page bulletin GEA-5530 to General Electric Co., Section 661-39, Schenectady 5, N. Y.

Combustion Gas Turbines for the Petroleum Industry

GENERAL ELECTRIC

Legality of Tidelands Gift To Navy Questioned

President Truman's recent order setting aside the submerged coastal lands as Naval Petroleum Reserves has drawn fire from various parts of the country. Texas senators and congressmen have attacked the order as being an attempt to "embarrass Eisenhower" who has already promised to sign a bill giving the title to the tidelands back to the states.

Senator Price Daniel was especially critical of Truman's statement that "it would be the height of folly for the U. S. to give away vast quantities of oil contained in the Continental Shelf and then buy back this same oil at stiff prices... in defense of the nation." Daniel said the experience with the naval reserve oil has been that every barrel cost more than buying it from private industry. He said the Federal Government did not have the know-how to explore and produce oil and that the Navy could buy it cheaper from private industry.

Senator Watkins, Republican from Utah, has questioned the legality of the order, and termed it a last minute effort to becloud the issue, and make it more difficult for President Eisenhower to deal with the question.

A fast attempt is being made to quash the edict through legislative action, which centers on two bills—twice vetoed by Truman—to establish state ownership. State oil lawmakers are counting on Eisenhower to cancel the order.

Tulsa Nomads make early start in their preparations for the May 14-23 International Petroleum Exposition. J. H. Beesley, Baroid Sales, National Lead, takes his turn at brush, while H. M. Cooley, Bethlehem Steel, supervises the project.

Outside Space Available At Tulsa Oil Show

Outside exhibit space is now available at the 1953 International Petroleum Exposition in Tulsa, Oklahoma, it has been disclosed by William B. Way, general manager of the May 14-23 show.

Options to past exhibitors and spontaneous requests for space resulted in a quick sell-out of the basic plant used for the 1948 show, Way said. He added that 20,000 sq ft of outside space in the new north area is now available, and it will be allocated to suit requirements.

June Rate of Output Tops May by 10 Per Cent

World crude petroleum production averaged 12,333,000 bbl daily in June, an increase of 10.2 per cent over the May rate. An important factor in the gain was an increase of 21.3 per cent in daily production in the United States, which averaged 6,197,000 bbl. Production in the Middle East reached a record 2,254,000 bbl daily during June, reflecting record daily average rates of 899,000 and 420,000 bbl in Saudi Arabia and Iraq respectively. Slight declines took place in Mexico (217,000 bbl daily during June vs. 219,000 bbl in May) and Venezuela, where daily average production in June dropped 1.0 per cent.

For the second successive month, crude imported into western Europe attained a record daily level. The June rate averaged 1,488,000 bbl, compared to 1,370,000 in May. Italy imported crude at a daily average rate of 18.3 per cent higher than in May.

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PERSONALS

Dr. Floyd L. Miller has completed his year's assignment in Washington, D. C., as vice chairman of the research and development board of the Department of Defense, it was announced by the Standard Oil Development Company, central research and engineering affiliate of the Standard Oil Company (New Jersey). Dr. Miller was loaned by the development company to the board. Concurrent with his return, the Standard Oil Development Company has appointed Dr. Miller to the post of manager of its contract, legal, and patent department.

Prior to his Washington appointment, Dr. Miller was head of the research division of Standard Oil Development. He joined the company in 1929, immediately after his graduation from the University of Michigan.

A series of promotions was made known by the Esso Laboratories of the Standard Oil Development Company.

Dr. Carl O. Tongberg is appointed director of the research division of the Esso Laboratories, **Dr. Charles L. Fleming, Jr.,** is made associate director, and **Gordon W. Duncan** becomes an assistant director of the same division.

The company also named two new section heads in its research division. **Dr. Joseph P. Hamer** is to head the automotive fuels and lubricants section, and **Elfried F. H. Pennekamp** the additives section. At the same time, **George S. Tobias** assumes new responsibilities as aviation contact representative.

Dr. Tongberg, who joined the Esso Laboratories in 1937, received his degrees from Harvard University and Pennsylvania State College.

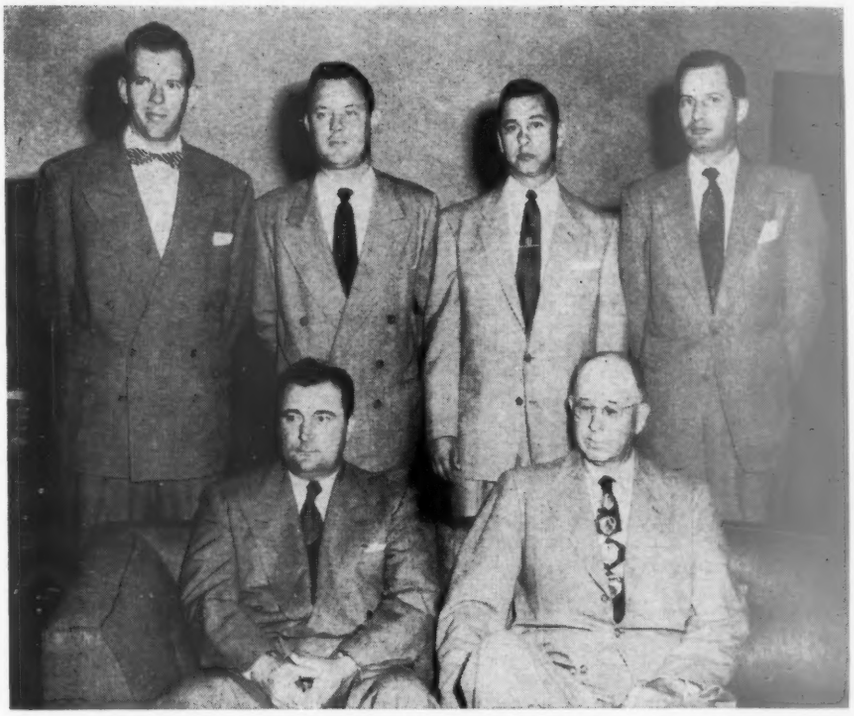
Dr. Fleming, who jonied the Esso Laboratories in 1938, was graduated from Dartmouth College and from the University of Illinois. Duncan gained both his bachelor's and his master's degrees from Pennsylvania State College, and joined Esso Lab in 1937. Dr. Hamer joined Esso Laboratories in 1947, having received his bachelor's degree from the University of Maryland, and his master's and doctor's degrees from Pennsylvania State College.

Pennekamp, a graduate of the University of Tennessee, has been associated with the Esso Laboratories since 1943. Tobias is a graduate of Ohio State University, where he gained both his bachelor's and his master's degrees in chemical engineering. He joined Esso Lab in 1946.

G. K. Barrett has been appointed assistant manager of the personnel department of The Ohio Oil Company. He was formerly assistant to the manager.

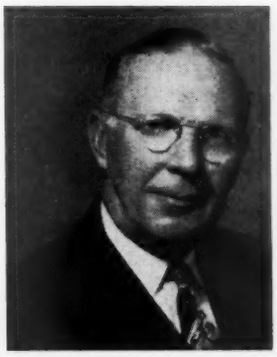
L. E. Cunningham, formerly manager of the wholesale credit department, has been appointed assistant credit manager.

Barrett is a graduate of the College of Wooster. After completing graduate work at the University of Michigan in 1940, he joined the General Electric Company benefits division. In 1949 he joined Ohio Oil. Cunningham joined Ohio Oil's credit department in 1931.

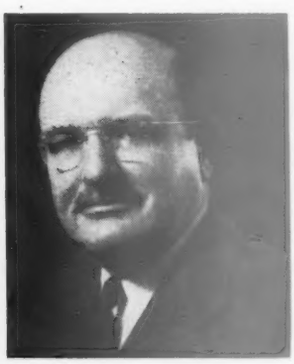


Dallas-FortWorth Chapter of Nomads officers for 1953 are: Seated, M. W. Hiltpold, vice president, and G. C. Waldrop, president; standing, Glenn A. Tableman, secretary; Abbott Sparks, sergeant-at-arms; R. E. Davidson, treasurer; E. F. Shiels, assistant treasurer. Not in the photograph are George W. Stevens, assistant secretary, and G. H. Lewis, deputy sergeant-at-arms.

Howard G. Vesper



George S. Dunham



Fred W. Bartlett

Howard G. Vesper has been elected vice president of Standard Oil Company of California. Vesper, who is president of California Research Corporation, Standard's research subsidiary, joined the oil company in 1922 following his graduation from the California Institute of Technology. He was manager of gasoline and fuel oil marketing when he became president of Cal-Research in 1946.

John Harper, president of Harper Oil Company, Inc., was appointed to membership on the National Petroleum Oil Council.

Merwin Bristol has been promoted from senior attorney in the law department to assistant general counsel of Standard Oil Company (Indiana). His office will continue to be at the company headquarters in Chicago, Illinois. Bristol joined the company in 1921 in Denver, Colorado, when the Midwest Refining Company, with which he was associated, became a part of the Standard organization. Bristol completed his legal education at the University of Denver.

George S. Dunham, vice chairman of Socony-Vacuum Oil Company's manufacturing committee, and **Fred W. Bartlett,** general manager of the producing department, have been named to the company's board of directors. **Wilbur F. Burt,** vice president in charge of coordination, is retiring after 40 years' service. **Charles L. Harding,** a director since 1948, was elected a vice president and member of the executive committee. **Clark S. Teitsworth,** a director since 1947, was designated to succeed Burt in charge of coordination, while Dunham was chosen to succeed Teitsworth as head of the manufacturing committee.

Bartlett joined Socony-Vacuum in 1939 after 17 years of oil experience in the United States and Mexico. He has been general manager of the producing department for the last three years. He is a University of Michigan graduate.

Dunham's first job in the oil industry was in Parco, Wyoming, shortly after his graduation from Cornell University in 1922. In 1936 he was named manager Socony-Vacuum's refinery engineering.

XUM

Personals

▸ **Horry F. Prioleau** has been named president and chief executive officer of Standard-Vacuum Oil Company, succeeding **Philo W. Parker,** who retires after more than 40 years in the international petroleum industry.

L. V. Collings, chairman of the board, announced at the same time that **A. W. Bourne, Jr.,** also is retiring as vice president and director, and that **C. B. Marshall** has been made vice chairman of the company's executive committee.

Parker, an officer and director of Standard-Vacuum continuously since its formation in 1933, has been the company's chief executive officer for the past six years. He is a graduate of Colgate in 1912.

Prioleau, who has been a vice president since 1949, has had 31 years of experience in the international oil business. He occupied successive posts in New York and Europe including that of general manager at The Hague for Standard-Vacuum.

Bourne, a Stanvac director since 1947 and a vice president for nearly three years, began his career as a marketer in Java 37 years ago. Subsequently he served at Singapore, London, and Hong Kong.

▸ **Charles P. Baker** has been appointed vice chairman of the manufacturing committee of Socony-Vacuum Oil Company, Inc., succeeding **George S. Dunham,** who was elected recently to the company's board of directors.

Baker has been a member of the manufacturing committee since February 1, 1952. Before that he was manager of Socony-Vacuum's East St. Louis, Illinois, refinery, a post he had held since 1946.

He joined Magnolia Petroleum Company, Socony-Vacuum affiliate in the Southwest, in 1934.

Baker was graduated in 1934 from the Agricultural and Mechanical College of Texas.

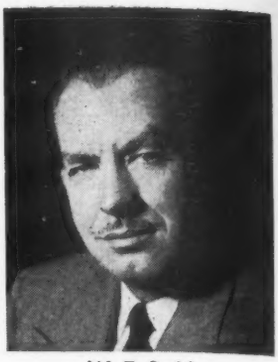
▸ **R. J. S. Pigott,** director of engineering, Gulf Research and Development Company, has retired from that position. He will, however, continue in the capacity of consultant. Pigott was graduated from Columbia University in 1906 with a degree in mechanical engineering. He holds more than 30 patents on devices used in hydraulic engineering, heating, oil production, and instruments.

E. Topanelian, Jr., has been appointed director of engineering, with **Bruce R. Walsh** as assistant director for Gulf Research. A graduate of Worcester Polytechnic Institute, Topanelian was formerly assistant director of the engineering division. Walsh, a Rose Polytechnic Institute graduate, has been head of the industrial engineering section, engineering division.

J. Edward Taylor, former member of the product development and product engineering department for Gulf Oil, has been transferred to the research department as director of automotive engineering with **Charles R. Butler** and **R. L. Kirkpatrick** as assistants to the director. Butler was in charge of the automotive section of the engineering division prior to his appointment, and Kirkpatrick was assistant head of the section.

Dr. M. E. Spaght

Dr. Harold Gershinowitz



W. E. Smith

▸ **Dr. M. E. Spaght,** president of the Shell Development Company of Emeryville, has been appointed to the newly created position of executive vice president of the Shell Oil Company, it was announced by President H. S. M. Burns. As president of Shell Development since 1949, Spaght has been in charge of all Shell research in the United States.

He will be replaced as head of the Shell research affiliate by **Dr. Harold Gershinowitz,** presently vice president of Shell Oil Company in charge of exploration and production research.

Spaght is also a director of the Shell Chemical Corporation, a director of the Stanford Research Institute, and a director-at-large of the Armed Forces Chemical Association. He joined Shell in 1933 as a research chemist at the Martinez refinery, after receiving his A.B., A.M., and Ph.D. degrees from Stanford University. He also has studied at the University of Leipzig.

Gershinowitz received his B.S. degree from the College of the City of New York, and his M.A. and Ph.D. from Harvard, later continuing in graduate research work at Princeton and Columbia. He has been with Shell since 1938.

▸ **W. E. Smith** has been transferred from British-American Oil Producing Company's western division office at Los Angeles to the headquarters office in Dallas, Texas. Smith's new duties will be those of assistant purchasing agent. Smith was graduated from the University of Colorado, and following graduation, was employed by the Public Service Company of Colorado.

▸ **Laurence A. Sunkel** has been elected a director of Atlantic Refining Company to fill the unexpired term of **E. J. Henry.** Sunkel is a vice president of Atlantic and general manager of crude oil production. He joined the company in the crude oil production department in 1919.

▸ **Wesley I. Nunn,** advertising manager, Standard Oil Company (Indiana) has been re-appointed volunteer coordinator of The Advertising Council's Stop Accidents campaign, it was announced by Howard J. Morgens, vice president in charge of advertising, The Procter and Gamble Company, council chairman. Nunn, who is a director of the Council, has served as volunteer coordinator of its Stop Accidents campaign since 1947.

William F. Kenney

A. L. Lyman

A. H. Batchelder

▸ **William F. Kenney,** vice president and general counsel of the Shell Oil Company, has been apointed a member of the American Petroleum Industries Committee. Kenney, who succeeded Cyrus S. Gentry as vice president and general counsel of Shell January 1, fills the committee vacancy created by Gentry's retirement. He obtained his doctorate in law from the University of Michigan, and joined Shell in 1937.

▸ **A. L. Lyman** has been elected to the newly-created position of executive vice president, by the board of directors of California Research Corporation. At the same time it was announced that **A. H. Batchelder** had been elected a vice president and director of this Standard Oil Company of California subsidiary. He also will be general manager of the Cal Research laboratories.

Lyman, who has been director of laboratories for Cal Research since 1946, joined Standard in 1924 following his graduation from University of California.

Batchelder joined Standard in 1930. He has been assistant director of the laboratories at Richmond since 1946.

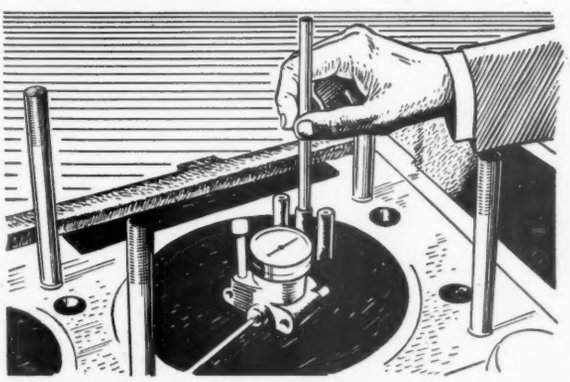
Cook job-engineered Piston Rings

...solve the case of the Prodigal Power Plant

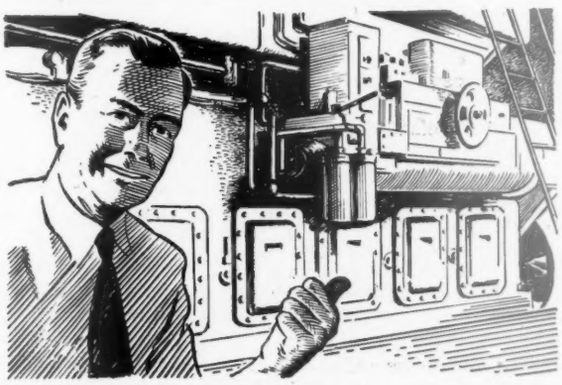
A large municipal power plant was being plagued by high maintenance and operating costs. Excessive ring breakage, cylinder lacquer and failure to hold compression pressures were the clues that pointed to the piston rings as the culprits. Despite the fact that the Chief Engineer rigidly observed the best operating procedures, the condition grew progessively worse. When it became necessary to pull pistons every 400 hours, he decided to call in Cook to make a "job-engineered" investigation of the mystery.

The Cook field man, who had been specially trained to diagnose diesel troubles, reviewed past performance data and suggested certain essential adjustments to "zero out" any operating variables.

A solution was recommended—but the Chief Engineer decided to make his own test. Old style rings were installed in 3 of the cylinders, competitive rings in 3 others and recommended Cook rings in the last 3 cylinders.



Results showed the old rings failed as quickly as before. The competitive rings stood up better but induced high rates of cylinder wear. Cook rings in operation for the same period revealed no ring failure, no lacquer and negligible cylinder wear.



The recommended Cook rings were installed throughout. After 4300 hours under full load, examination showed rings were still in perfect condition, no sign of lacquer and total cylinder wear only .0030". The prodigal power plant had returned to the fold.

Job Engineering is an exclusive Cook service which assures scientific selection and application of piston rings to your specific operating and engine conditions. Take advantage of it.

C. Lee Cook Mfg. Co., Incorporated, Louisville, Ky. Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK
PISTON RINGS

. . . SEALING PRESSURES SINCE 1888 . . .

Personals

Kirk E. Boone, general counsel for Bankline Oil Company, is retiring from active practice because of ill health. Boone has been handling the company's legal matters since 1930, and has been a director since 1945. The company has requested him to remain as a director, should his health permit.

Bert I. Graves, vice president and director of the Tide Water Associated Oil Company, has been named a member of the newly created board for development at New York University. Graves and other members of the new board will help determine and implement policies in connection with the university's 10-year, $102,000,000 program for new buildings and endowment. Chairman of the group is Charles R. Cox, president of the Kennecott Copper Corporation and a member of the University Council, governing body of the institution.

H. H. (Bob) Roberts has been appointed assistant manager of the public relations department of Standard Oil Company of California. His office is in Los Angeles.

Roberts has been Standard's public relations representative in Southern California since 1925. He joined the company in 1916 following graduation from the University of California at Berkeley.

He belongs to Western Oil and Gas Association and Petroleum Production Pioneers.

Hugh H. Sharpe, III, has been named district representative of the Oil Industry Information Committee in the New England district. Simultaneously it was announced that the New England district office of the OIIC has been moved from 100 Boylston Street, Boston, to 419 Boylston Street. Sharpe comes to the OIIC from the position of production manager for Radio Station WLAW of Boston and Lawrence, Massachusetts.

O. J. Glasman, office manager of the Detroit, Michigan, district, Standard Oil Company, has become administrative assistant in the office of Frank O. Prior, executive vice president, at the company's general office in Chicago. Glasman joined Standard in 1924 and was made office manager of the Detroit district last year.

Doris Whiteside, executive secretary for Charles E. Simons, vice president of Texas Mid-Continent Oil and Gas Association, has been named private secretary to the new Secretary of the Navy, R. B. Anderson. Miss Whiteside holds bachelor and master degrees from North Texas State College. She has been director of Region 6 for the national Desk and Derrick Club.

Martha Binford, secretary, with the Seaboard Oil Company, has been named vice chairman for the women's program for the state of Texas by the Oil Industry Information Committee of the American Petroleum Institute. Mrs. Binford, former president of Dallas Desk and Derrick Club, is the first woman to be named to the post by OIIC.

William J. Getty, editor of Sun Oil Company's quarterly house publication *Our Sun,* has been promoted to the public relations department's special events division to assist in handling special and major undertakings. William H. Burns, associate editor, has been named editor of the publication.

Other Sun public relations department changes announced were:

Henry C. Gulbrandsen, editor of the monthly *Sun Refinery News,* to be associate editor, *Our Sun,* succeeding Burns. **Earle W. Palmer,** public relations staff assistant, Philadelphia, to be editor of *Sun Refinery News,* Marcus Hook, succeeding Gulbrandsen.

Ellen C. Talbot, special assistant to the director of public relations, transferred to the Pew Memorial Foundation.

Sidney M. Blair of Toronto and **Donald L. Roberts** of Vancouver have been elected directors of Canadian Bechtel Ltd. Both Blair and Roberts are vice presidents of Canadian Bechtel Ltd. In addition, Blair is a vice president of Trans Mountain Oil Pipe Line Company.

Blair attended the University of Toronto and the University of Alberta, from which he obtained a Master of Science degree. Roberts, who was graduated from the South Dakota School of Mines with a civil engineering degree in 1933, joined Bechtel in 1942.

John C. Sample, a director of General Petroleum Corporation, has been elected vice president. He will coordinate the company's manufacturing, pipe line, and supply activities. **R. O. Swayze** has been elected vice president and director of production. He succeeds **M. S. App,** who is retiring.

J. T. Durkee has been elected treasurer and a director, succeeding **Wesley Cunningham,** who is also retiring. Durkee retains the post of comptroller.

A. D. Bennison, manager of the oil exchange and supply department, has been elected director of oil supply.

A. O. Woll, director of the company's marine department, is also retiring. No successor director was named.

J. M. (Marty) Hanlon, recently active in South Carolina oil distributor relationships for the Richfield Oil Corporation, has been named district manager for this state. He was formerly a distributor salesman for the company. A graduate of Georgetown University, Hanlon joined Richfield early in 1948, bringing to the company a rich background in the oil business.

Leonard W. Groce has been appointed assistant treasurer of Humble Oil and Refining Company, with supervision over the banking section. His new duties include the receiving and disbursing of company funds and the maintenance of relations between Humble and a number of banks. Groce joined the company in 1934. When Humble's annuity and thrift plan was organized in 1936 to replace the earlier stock purchase system for employees, he became a member of the section which administers the plan.

Virginia Dupies, secretary to Frank I. Brinegar, executive vice president of The Continental Supply Company, has been elected president of the Dallas Desk & Derrick Club for 1953. Other officers are: First vice president, Hazel Jeanes, Harry Bass Drilling; second vice president, Marguerite Reavis, Seaboard; treasurer, Frankie Frensley, W. P. Luse; corresponding secretary, Josephine Buell, Floyd C. Ramsey, and recording secretary, Helen Mourning, Reagan J. Caraway.

DEATHS

J. M. P. McCraven, manager of the railway sales department of The Texas Company, died early December 30. McCraven was first employed by The Texas Company at Houston, Texas, as a clerk and advanced through various positions in the railway sales department of the company to his appointment as manager in 1948.

Donald Lincoln, manger of the refinery supply and distribution division of Sun Oil Company, died December 29. Lincoln joined Sun Oil in 1930 at the Marcus Hook refinery. He was later transferred to Sun's Philadelphia office, where he helped to organize the production control division. He was named manager of the refinery supply and distribution division when it was organized in January 1946.

Frank M. Mason, vice president of U. S. Electrical Motors Inc., passed away December 27 of a heart attack. He was general manager of the company's Atlantic plant in Milford, Connecticut. Prior to the erection of that plant in 1940, he was assistant chief engineer of the U. S. Motors Pacific plant in Los Angeles.

Arthur W. Ambrose, well-known oil executive, and his wife, the former Alma Locke, were killed in an automobile accident near Tulsa, Oklahoma, December 28.

Born in Lockeford, California, in 1889, Ambrose was graduated from Stanford University with an A.B. degree in geology. He began his career in the field of petroleum in 1914 as a geologist for Shell Oil Company in the Coalinga field in California. He joined Cities Service Oil Company, an operating subsidiary of Cities Service Company, in 1923 as manager of its land and geological division. In 1930 he was promoted to vice president and assistant general manager, and in 1946 he was elected to the presidency of the company. In January, 1952, Ambrose became chairman of the board of Cities Service Oil Company, Delaware, with headquarters in Bartlesville, Oklahoma. He was a director of Cities Service Company and Richfield Oil Corporation.

A. D. McTaggart, employee of Acme Fishing Tool Company, for more than 39 years, died recently. At the time of his death he was plant superintendent. He began his oil tool making career under Acme's founder, George L. McKain. He was widely known among drillers and cable tool men throughout the oil fields.

NEW!

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This bulletin contains specifications, engineering and performance data, photos and descriptions of recommended types of filter media, check list of liquids that can be filtered and other helpful data.

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- LIST OF LIQUIDS THAT CAN BE FILTERED
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- PERFORMANCE DATA
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ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

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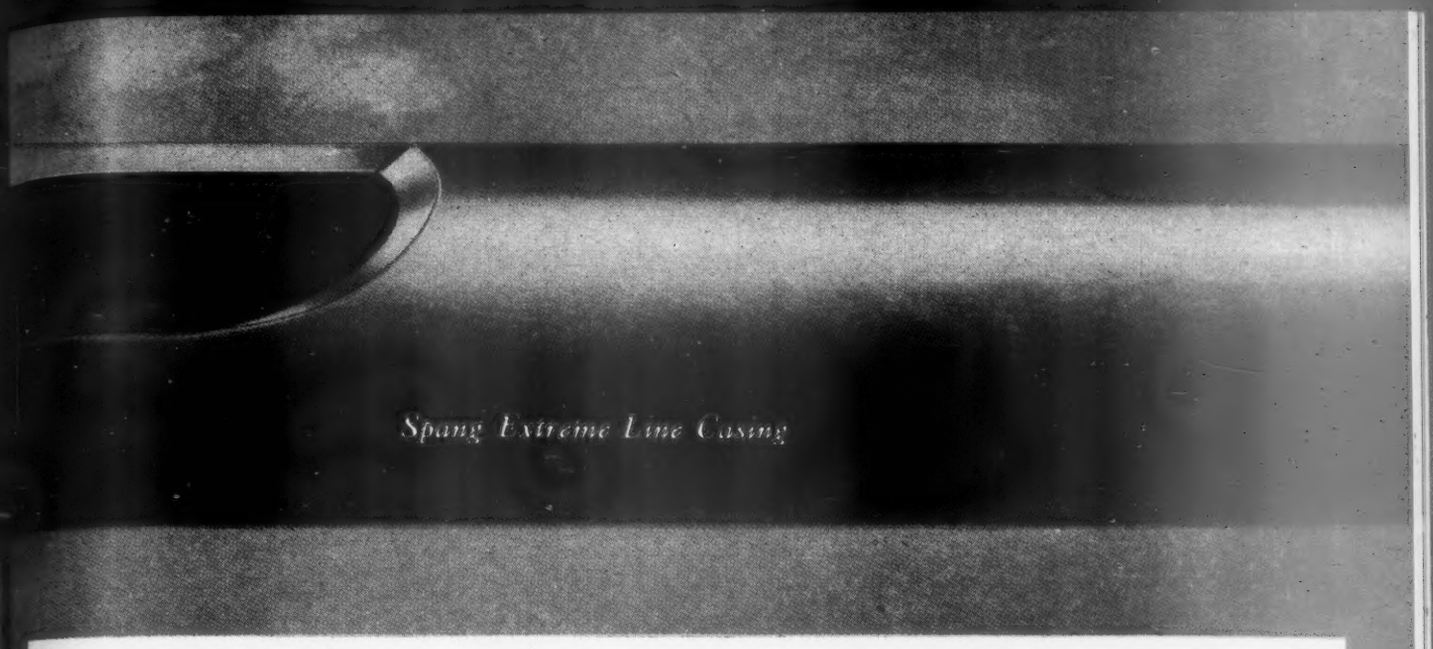

Spang Extreme Line Casing

. . . by any standard of comparison they measure up to maximum service requirements

Throughout its many years of service to the petroleum industry the Spang-Chalfant Division of National Supply has been the source of the most complete range of oil country tubular products, and the most advanced in engineering, metallurgy and manufacturing.

The long list of tubular products bearing the Spang trademark is evidence of the research and continuous product development carried out at the Ambridge, Pennsylvania, laboratories, and throughout the world of oil with which National's field organization is in daily contact.

Thus the introduction of new Spang tubular products, such as Spangseal Tubing and Spangweld Drill Pipe, is further indication that National's equipment development program is keeping pace with the petroleum industry's demands.

By any standard of comparison your investment in drill pipe, casing, or tubing bearing the Spang Trademark is your assurance of adequate returns in serviceability, and trouble-free performance. The latest bulletin on Spang drill pipe and tool joints contains valuable information you'll want for your reference files—write Pittsburgh for your copy.

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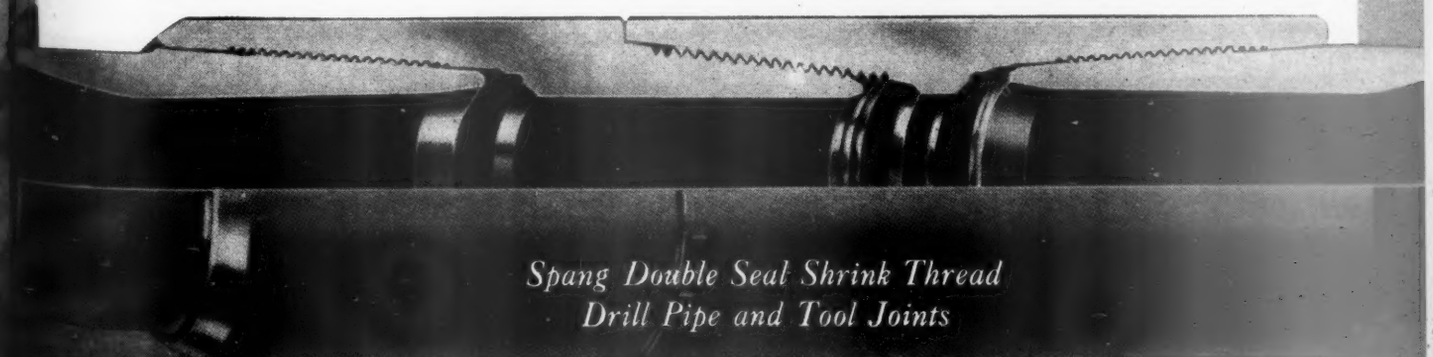
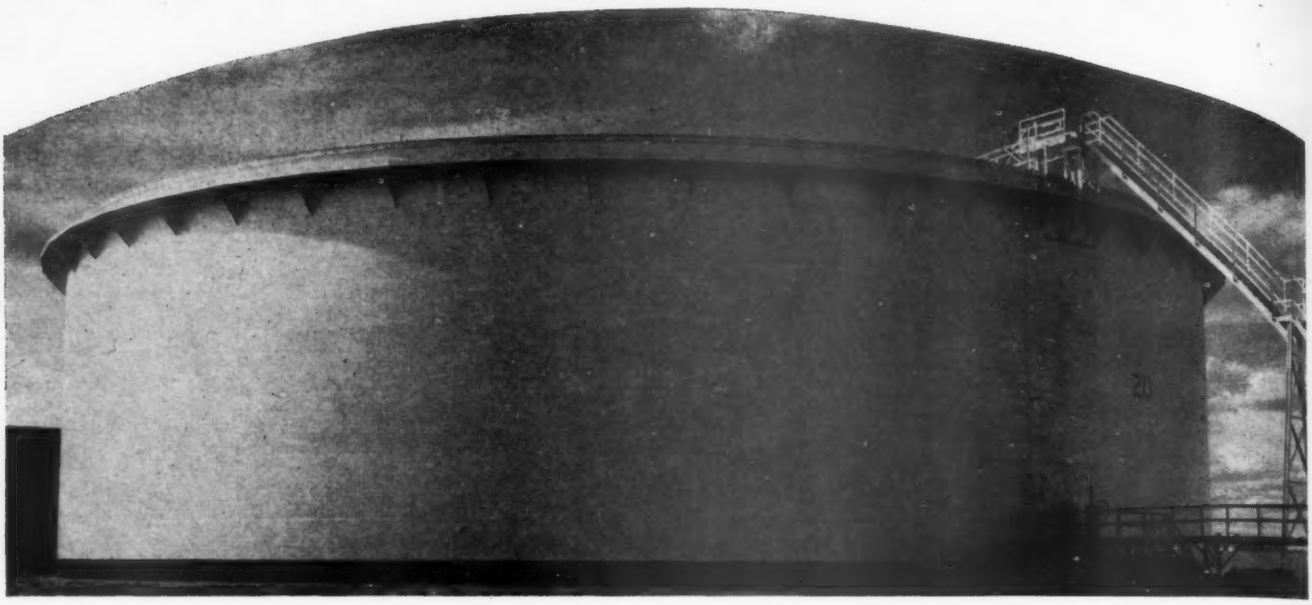


Spang Double Seal Shrink Thread Drill Pipe and Tool Joints

XUM



Horton Floating Roofs Eliminate Three Problems

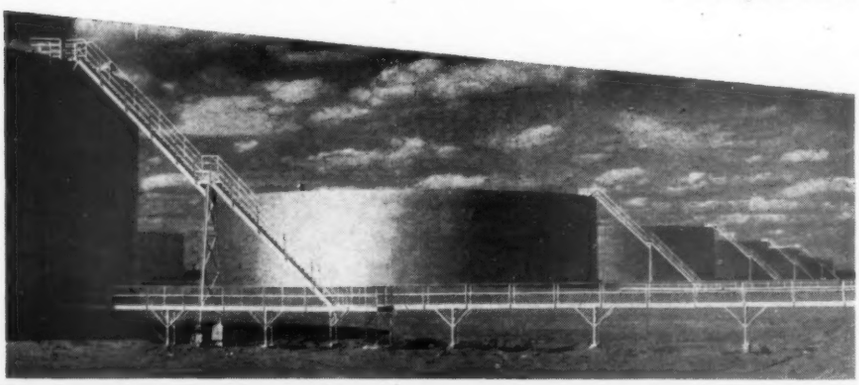
When storing a volatile liquid, the three major problems are (1) how to reduce costly evaporation loss, (2) how to protect the tank from fire, and (3) how to reduce excessive corrosion on the inside of the tank. The key to all three of these problems is the elimination of the air-vapor mixture above the liquid. Equipping storage tanks with Horton Floating Roofs is the answer.

Floating directly on the surface, the entire bottom of a Horton Floating Roof is normally in contact with the liquid in the tank. The air-vapor mixture above the liquid is eliminated . . . evaporation loss due to filling or breathing is stopped.

Corrosion and fire hazard are also reduced as a result of the elimination of the vapor space. With the bottom of the Horton Floating Roof normally in contact with the liquid, the corrosion which would take place if air were present, is retarded. Blanketing the surface of the liquid, the Horton Floating Roof eliminates the air necessary to combustion . . . and licks the fire hazard.

There are twelve 150,000-bbl. and twenty-four 217,000-bbl. Horton tanks at the Lakehead Pipe Line Station at Superior, Wisconsin. Several of these tanks are equipped with Horton Pontoon Floating Roofs. We also erected two Horton cone-roof welded steel tanks, one 30 ft. diam. by 40 ft. and one 67 ft. diam. by 48 ft., at the Lakehead dock, approximately two miles away from the general storage area.

Horton Floating Roofs are built in three types . . . Double-Deck, Pontoon, and Pan. Our nearest office will be happy to help you select the type most suitable to your operation . . . or to give you further information on cone-roof tanks, Hortonspheres, Hortonspheroids, Vaporspheres, or any other special steel plate structure you may need.



Above: One of the 217,000-bbl. tanks equipped with Horton Pontoon Floating Roofs at the Lakehead Pipe Line Station near Superior, Wisconsin.

Left: Row of Horton cone-roof tanks at the Lakehead Pipe Line Station near Superior.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY *and* GREENVILLE, PENNSYLVANIA

Atlanta.....2174 Healey Bldg.
Birmingham 1.....1570 North Fiftieth St.
Boston 10.....1028—201 Devonshire St.
Chicago 4.....2481 McCormick Bldg.
Cleveland 15.....2251 Midland Bldg.
Detroit 26.....1538 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston 2.....2137 C & I Life Bldg.
Los Angeles 17...1546 General Petroleum Bldg.
New York 6.....3373—165 Broadway Bldg.
Philadelphia 3..1635—1700 Walnut Street Bldg.
San Francisco 4.....1564—200 Bush St.
Seattle 1.....1329 Henry Bldg.
Tulsa 3.....1634 Hunt Bldg.

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Horton Steel Works, Limited, Fort Erie, Ontario, Canada
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Chicago Bridge & Iron Company, Ltd., Apartado 1348, Caracas, Venezuela
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TON MILES

4-in. drill pipe — 14.0 lb. per foot

50,000 lb EXCESS WEIGHT

DEPTH	0	100	200	300	400	500	600	700	800	900
0	0	2	4	6	8	10	12	14	16	19
1000	20	22	25	27	29	31	34	36	38	41
2000	43	46	48	51	53	56	58	61	63	66
3000	69	71	74	77	79	82	85	88	91	93
4000	96	99	102	105	108	111	114	117	120	124
5000	127	130	133	136	139	143	146	149	153	156
6000	160	163	166	170	173	177	180	184	188	191
7000	195	199	202	206	210	213	217	221	225	229
8000	233	237	241	245	249	253	257	261	265	269
9000	273	277	281	286	290	294	299	303	307	312
10000	316	320	325	329	334	338	343	348	352	357
11000	361	366	371	375	380	385	390	395	399	404
12000	409	414	419	424	429	434	439	444	449	455
13000	460	465	470	475	480	486	491	496	502	507
14000	513	518	523	529	534	540	545	551	557	562
15000	568	574	579	585	591	597	602	608	614	620
16000	626	632	638	644	650	656	662	668	674	680
17000	686	692	699	705	711	717	724	730	736	743
18000	749	756	762	769	775	782	788	795	801	808
19000	815	821	828	835	841	848	855	862	869	876

55,000 lb EXCESS WEIGHT

0	0	2	4	7	9	11	13	15	18	20
1000	22	25	27	29	32	34	37	39	42	44
2000	47	50	52	55	58	60	63	66	69	71
3000	74	77	80	83	86	89	92	95	98	101
4000	104	107	110	113	117	120	123	126	130	133
5000	136	140	143	146	150	153	157	160	164	167
6000	171	175	178	182	185	189	193	197	200	204
7000	208	212	216	220	224	228	232	236	240	244
8000	248	252	256	260	265	269	273	277	281	286
9000	290	293	299	303	308	312	317	321	326	330
10000	335	340	344	349	354	358	363	368	373	377
11000	382	387	392	397	402	407	412	417	422	427
12000	432	437	442	447	453	458	463	468	474	479
13000	484	490	495	500	506	511	517	522	528	533
14000	539	545	550	556	562	567	573	579	585	591
15000	596	602	608	614	620	626	632	638	644	650
16000	656	662	668	675	681	687	693	699	706	712
17000	718	725	731	738	744	751	757	764	770	777
18000	783	790	797	803	810	817	823	830	837	844
19000	851	857	864	871	878	885	892	899	906	913

60,000 lb EXCESS WEIGHT

0	0	2	5	7	9	12	14	17	19	22
1000	24	27	29	32	34	37	40	43	45	48
2000	51	54	56	59	62	65	68	71	74	77
3000	80	83	86	89	92	95	99	102	105	108
4000	112	115	118	122	125	128	132	135	139	142
5000	146	150	153	156	160	164	167	171	175	179
6000	182	186	190	194	198	202	205	209	213	217
7000	221	226	230	234	238	242	246	250	255	259
8000	263	267	272	276	280	285	289	294	298	303
9000	307	312	316	321	326	330	335	340	344	349
10000	354	359	363	368	373	378	383	388	393	398
11000	403	408	413	418	423	429	434	439	444	449
12000	455	460	465	471	476	482	487	492	498	503
13000	509	514	520	526	531	537	543	548	554	560
14000	566	571	577	583	589	595	601	607	613	619
15000	625	631	637	643	649	655	661	668	674	680
16000	686	693	699	705	712	718	725	731	738	744
17000	751	757	764	770	777	784	790	797	804	811
18000	817	824	831	838	845	852	859	865	873	880
19000	887	894	901	908	915	922	929	929	944	951

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4-in., 14.0 lb drill pipe and 55,000 lb excess weight = 458.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation

ANNOUNCING
THE NEW
LUNKENHEIMER
VALVE
HANDWHEEL

"non-slip"* for positive closing

This revolutionary "Non-Slip" Handwheel introduces another Lunkenheimer improvement! Four rounded, non-slip lugs are gripped comfortably and firmly —operator's hand can't slip, even when wet or greasy. Result: Ordinary hand leverage closes the valve tight.

The new "Non-Slip" Handwheel is cooler, too—and keeps the operator's hand away from the top of the stem, which may be hot. It's sturdier, easier to operate, and makes your valves last longer.

*Patent Pending

WRITE FOR the name of your nearest Lunkenheimer distributor. He can show you samples of Lunkenheimer Valves with the new "Non-Slip" Handwheel. See them for yourself — *test them.* The Lunkenheimer Company, Box 360-H, Cincinnati 14, Ohio.

BRONZE • IRON • STEEL

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-152-29

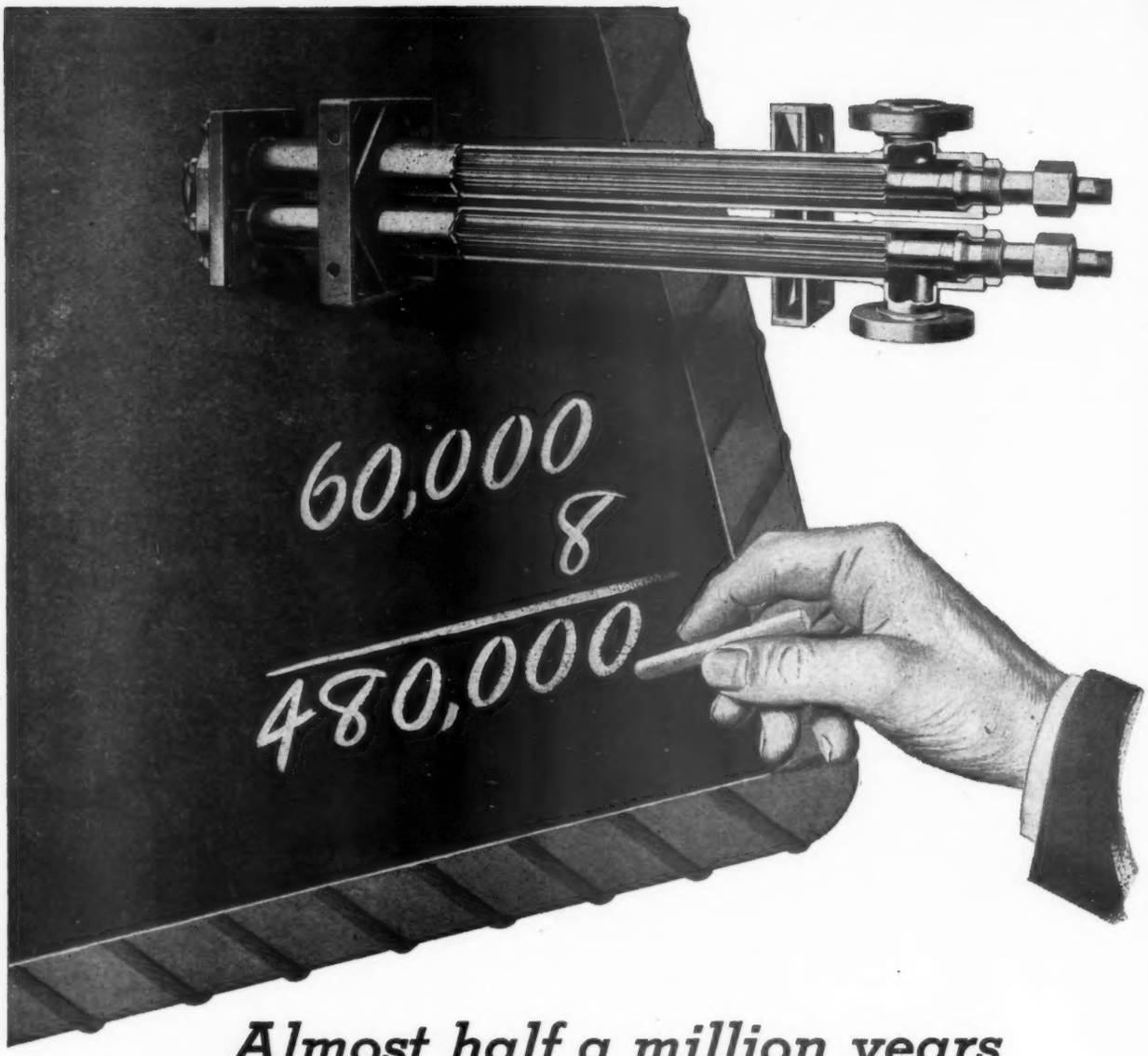
TON MILES

4-in. drill pipe — 15.7 lb. per foot

DEPTH	0	100	200	300	400	500	600	700	800	900
15,000 lb EXCESS WEIGHT										
0	0	1	2	2	2	3	4	5	5	6
1000	7	8	9	10	11	12	13	14	15	16
2000	17	18	20	21	22	23	24	25	27	28
3000	30	31	33	34	36	37	39	41	42	44
4000	47	47	49	51	53	54	56	58	60	62
5000	64	66	68	70	72	74	76	78	81	83
6000	85	87	90	92	94	97	99	101	104	106
7000	109	111	114	117	119	122	125	127	130	133
8000	136	138	141	144	147	150	153	156	159	162
9000	165	168	171	175	178	181	184	187	191	194
10000	197	201	204	208	211	215	218	222	225	229
11000	233	236	240	244	247	251	255	259	263	266
12000	270	274	278	282	286	290	294	299	303	307
13000	311	315	320	323	328	332	337	341	346	350
14000	354	359	364	368	373	377	382	387	391	396
15000	401	406	410	415	420	425	430	435	440	445
16000	450	455	460	465	470	475	481	486	491	496
17000	502	507	512	518	523	529	534	540	545	551
18000	556	562	567	573	579	585	590	596	602	608
19000	614	619	625	631	637	643	649	655	661	668
20,000 lb EXCESS WEIGHT										
0	0	1	2	2	3	4	5	6	7	8
1000	9	10	11	12	14	15	16	17	18	20
2000	21	22	24	25	26	28	29	31	32	34
3000	36	37	39	41	42	44	46	48	49	51
4000	53	55	57	59	61	63	65	67	69	71
5000	73	76	78	80	82	84	87	89	92	94
6000	96	99	101	104	106	109	112	114	117	120
7000	122	125	128	131	133	136	139	142	145	148
8000	151	154	157	160	163	166	169	173	176	179
9000	182	185	189	192	196	199	202	206	209	213
10000	216	220	224	227	231	235	238	242	246	250
11000	253	257	261	265	269	273	277	281	285	289
12000	293	297	301	306	310	314	318	323	327	331
13000	336	340	345	348	353	358	363	367	372	376
14000	381	386	390	395	400	405	410	414	419	424
15000	429	434	439	444	449	454	459	465	470	475
16000	480	485	491	496	501	507	512	517	523	528
17000	534	539	545	550	556	562	567	573	579	584
18000	591	596	602	608	614	620	626	632	638	644
19000	650	656	662	668	674	680	686	693	699	705
25,000 lb EXCESS WEIGHT										
0	0	1	2	3	4	5	6	7	8	10
1000	11	12	13	15	16	18	19	20	22	23
2000	25	26	28	29	31	33	34	36	38	39
3000	41	43	45	47	49	51	53	55	57	59
4000	61	63	65	67	69	71	74	76	78	80
5000	83	85	88	90	92	95	97	100	103	105
6000	108	110	113	116	119	121	124	127	130	133
7000	135	138	141	144	147	150	153	157	160	163
8000	166	169	172	176	179	182	186	189	192	196
9000	199	203	206	210	213	217	221	224	228	232
10000	235	239	243	247	251	254	258	262	266	270
11000	274	278	282	286	291	295	299	303	307	312
12000	316	320	325	329	333	338	342	347	351	356
13000	360	365	370	374	379	384	388	393	398	403
14000	408	412	417	422	427	432	437	442	447	452
15000	458	463	468	473	478	484	489	494	500	505
16000	510	516	521	527	532	538	543	549	555	560
17000	566	572	577	583	589	595	601	607	613	618
18000	624	630	636	642	649	655	661	667	673	679
19000	686	692	698	704	711	717	724	730	737	743

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4-in., 15.7 lb drill pipe and 15,000 lb excess weight = 290.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation



Almost half a million years of heat exchanger service!

Multiply the number of installed G-R Twin G-Fin Sections by a conservative estimate for average length of service and that's the figure you get . . . almost half a million total years of service!

Some Twin G-Fin Sections have been in continuous use for more than 20 years. And no matter what the length of service or type of heat transfer duty, here is the uniform report of users . . . . effective, durable, troublefree, economical.

Twin G-Fin Sections can be used for a greater variety of services than any other design of heat transfer apparatus . . . that's one of their many advantages. Their installations include almost every type of heating, cooling, condensing, and heat exchange, and with many different liquids, gases and vapors.

Investigate the possibilities in your own plant for these time-proven standard interchangeable heat exchangers with the famous G-Fin elements. Write for bulletin, and ask about their applications to your heat transfer needs.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

G-R *Twin G-Fin Section*

HEAT TRANSFER APPARATUS

GR 280

TON MILES

4-in. drill pipe — 15.7 lb. per foot

30,000 lb EXCESS WEIGHT

DEPTH	0	100	200	300	400	500	600	700	800	900
0	0	1	2	4	5	6	7	9	10	11
1000	13	14	16	17	19	20	22	24	25	27
2000	29	30	32	34	36	37	39	41	43	45
3000	47	49	51	53	55	57	59	62	64	66
4000	68	71	73	75	78	80	82	85	87	90
5000	92	95	97	100	103	105	108	111	114	116
6000	119	122	125	128	131	134	137	140	143	146
7000	149	152	155	158	161	165	168	171	174	178
8000	181	184	188	191	195	198	202	206	209	213
9000	216	220	224	227	231	235	239	243	247	250
10000	254	258	262	266	270	274	278	283	287	291
11000	295	299	304	308	312	316	321	325	330	334
12000	339	343	348	352	357	361	366	371	375	380
13000	385	390	395	399	404	409	414	419	424	429
14000	434	439	444	449	455	460	465	470	475	481
15000	486	491	497	502	508	513	519	524	530	535
16000	541	546	552	558	563	569	575	581	587	592
17000	598	604	610	616	622	628	634	640	646	652
18000	659	665	671	677	683	690	696	702	709	715
19000	722	728	735	741	748	754	761	767	774	781

35,000 lb EXCESS WEIGHT

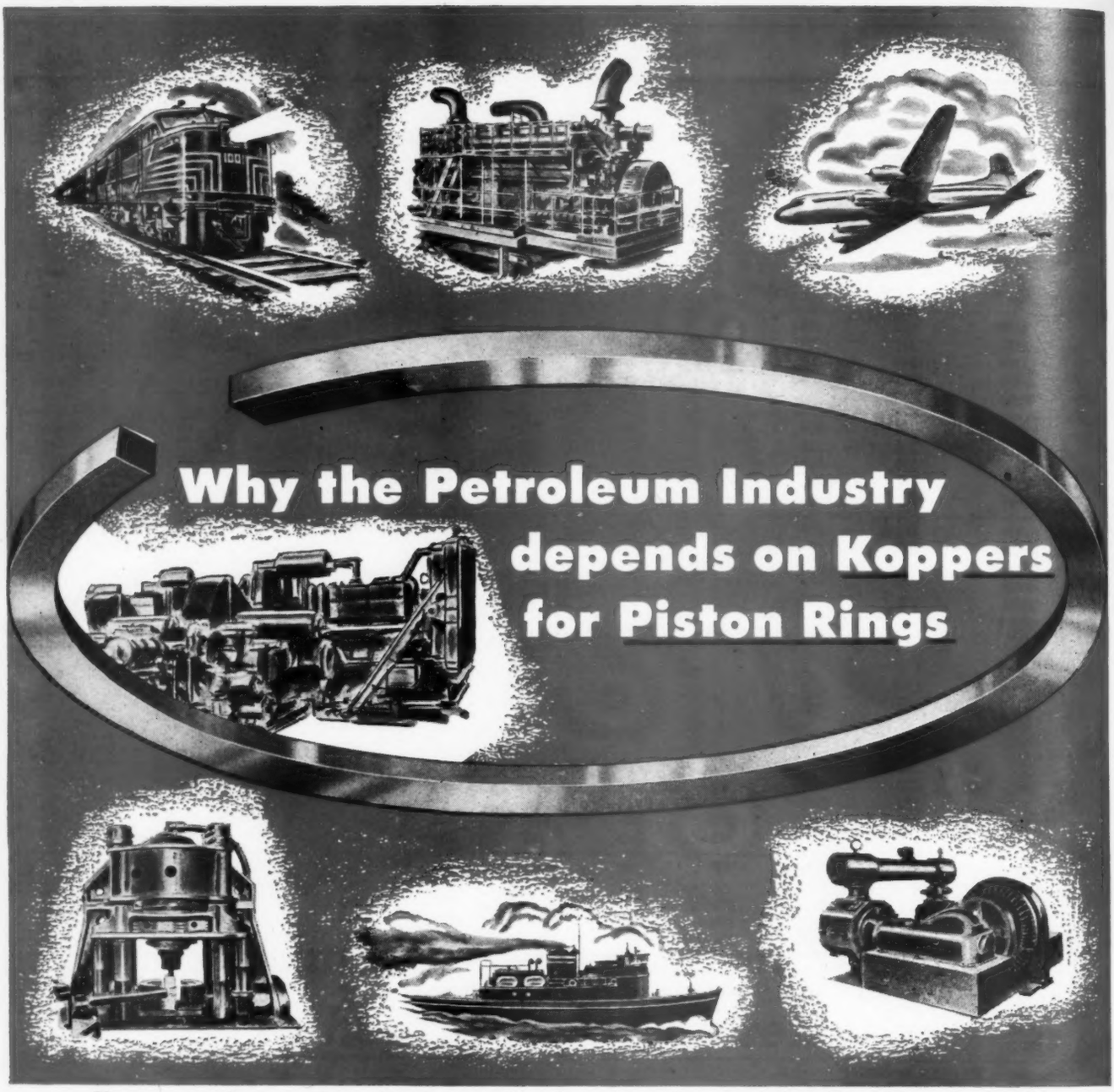
0	0	1	3	4	6	7	8	10	12	13
1000	15	16	18	20	21	23	25	27	29	30
2000	32	34	36	38	40	42	44	46	48	50
3000	53	55	57	59	62	64	66	69	71	73
4000	76	78	81	83	86	88	91	94	96	99
5000	102	105	107	110	113	116	119	122	125	127
6000	130	134	137	140	143	146	149	152	156	159
7000	162	165	169	172	175	179	182	186	189	193
8000	196	200	203	207	211	214	218	222	226	230
9000	233	237	241	245	249	253	253	257	265	269
10000	273	277	282	286	290	294	299	303	307	312
11000	316	320	325	328	334	338	343	348	352	357
12000	361	366	371	376	380	385	390	395	400	405
13000	410	415	420	424	430	435	440	445	450	455
14000	461	466	471	476	482	487	493	498	503	509
15000	514	520	526	531	537	542	548	554	559	565
16000	571	577	583	589	594	600	606	612	618	624
17000	630	637	643	649	655	661	667	674	680	686
18000	693	699	705	712	718	725	731	738	744	751
19000	758	764	771	778	784	791	798	805	812	818

40,000 lb EXCESS WEIGHT

0	0	2	3	5	6	8	10	11	13	15
1000	17	18	20	22	24	26	28	30	32	34
2000	36	38	40	43	45	47	49	51	54	56
3000	53	61	63	66	68	71	73	76	78	81
4000	83	86	89	91	94	97	100	103	105	108
5000	111	114	117	120	123	126	129	132	136	139
6000	142	145	148	152	155	158	162	165	168	172
7000	175	179	182	186	189	193	197	200	204	208
8000	211	215	219	223	227	231	234	238	242	246
9000	250	254	259	263	267	271	275	279	284	288
10000	292	297	301	305	310	314	319	323	328	332
11000	337	340	346	351	355	360	365	370	374	379
12000	384	389	394	399	404	409	414	419	424	429
13000	434	439	445	449	455	460	466	471	476	482
14000	487	493	498	504	515	520	526	526	531	537
15000	543	549	554	560	566	572	578	584	589	595
16000	601	607	613	620	626	632	638	644	650	656
17000	663	669	675	682	688	694	701	707	714	720
18000	727	733	740	747	753	760	767	773	780	787
19000	794	800	807	814	821	828	835	842	849	856

EXAMPLE: Ton miles per round trip at depth of 12,500 ft with 4-in., 15.7 lb drill pipe and 35,000 lb excess weight = 385.

Courtesy Wickwire Rope, The Colorado Fuel and Iron Corporation



Koppers manufactures piston rings in every size, of every type, for every industrial and aircraft purpose.

FROM all parts of the petroleum industry come reports of savings in time, labor and money through the use of Koppers Rings in pumps, compressors, diesel and gas engines and other equipment. That's because Koppers research and engineering keep up with modern advances in equipment design by constantly improving ring materials and manufacturing methods.

Koppers K-Iron® Rings are made of a high-grade, closely-controlled material that imparts improved wear properties and is surface treated chemically as an anti-scuffing aid. They are made in diameters to 120" in a variety of joint types. Koppers Porous Chrome* Rings hold and distribute oil during break-in, quickly wear to best possible seating...*cut cylinder wear up to 50%, last 4 times as long as ordinary rings!*

Our engineers, who work with you in determining the best rings for your applications, have all the facilities of the large, modern Koppers piston ring plant at their disposal . . . to supply you with rings that cut down-time, increase efficiency and lengthen the life of your equipment.

WRITE, wire or phone us today for experienced help with your piston ring problems. KOPPERS COMPANY, INC., *Piston Ring Dept.*, 1592 Hamburg St., Baltimore 3, Md. **Van der Horst Process*

KOPPERS ®

Koppers American Hammered Industrial Piston Rings

Only **KOPPERS** *can furnish K-Spun® and Porous Chrome!*

FRICTION LOSS IN OIL PIPE LINES—PER 100 FT.

Engle	52	58	70	96	155	355	700	1400	2100	2800	3500	4200	5600	7000
Engler Degrees	1.0	1.1	1.4	1.9	3.1	7.0	13.8	27.6	41.4	55.2	69	83	110	138
Redwood Std.	28	30	38	54	90	210	420	840	1260	1680	2100	2520	3360	4200
Saybolt Furol					15	27	50	95	143	190	238	85	380	475
Saybolt Univ.	31	34	43	61	103	237	475	950	1425	1900	2375	2850	3800	4750
Centipoises	1	2	5	10	20	50	100	200	300	400	500	600	800	1000

G.P.M.	Pipe size	Friction head																									
		*		*		*		*		*		*		*		*		*		*		*		*		*	
3	½	10	1.2	12	1.2	15	1.2	18	1.3	25	1.4	63	0.8	127	0.4	253	0.2	380	0.2	506	0.2	633	0.2	750	0.2	.....	.....	.....	.....
	¾	3	1.6	3	1.6	4	1.6	5	1.9	8	1.6	20	0.8	41	0.4	82	0.3	123	0.2	164	0.2	205	0.2	246	0.2	328	0.2	410	0.2
	1	1	2.0	1	2.0	1	2.1	2	2.5	3	1.8		0.8	16	0.4	31	0.3	47	0.3	62	0.2	78	0.2	94	0.2	125	0.2	156	0.2
5	¾	6	1.7	8	1.6	10	1.6	12	1.7	14	2.0	34	1.3	68	0.7	137	0.4	205	0.3	273	0.3	342	0.2	410	0.2	547	0.2	684	0.2
	1	2	2.1	2	2.0	3	2.0	4	2.2	5	2.3	13	1.3	26	0.7	52	0.4	79	0.3	105	0.3	131	0.3	152	0.3	210	0.2	262	0.2
	1¼	1	2.7	1	2.7	1	2.7	1	3.2	2	2.7	4	1.4	9	0.7	17	0.4	26	0.4	35	0.3	43	0.3	52	0.3	69	0.3	87	0.3
8	¾	14	1.7	17	1.6	22	1.6	26	1.6	31	1.8	54	1.7	108	1.0	216	0.6	325	0.4	433	0.3	541	0.3	649	0.2	.....	.....	.....	.....
	1	4	2.1	5	2.1	7	2.0	8	2.1	10	2.4	21	1.9	41	1.0	83	0.6	124	0.4	165	0.3	206	0.3	248	0.3	330	0.3	413	0.2
	1¼	1	2.8	2	2.6	2	2.6	2	2.8	3	3.2	7	2.0	14	1.1	27	0.6	41	0.5	54	0.4	69	0.4	82	0.3	110	0.3	137	0.3
12	1	9	2.2	11	2.	14	2.0	17	2.0	20	2.1	31	2.3	62	1.5	125	0.8	187	0.6	250	.5	312	0.4	374	0.4	499	0.3	624	0.3
	1¼	2	2.8	3	2.8	4	2.6	5	2.7	6	3.0	11	2.7	21	1.6	42	0.9	62	0.6	83	0.5	104	0.4	125	0.4	167	0.4	208	0.3
	1½	1	3.2	1	3.2	2	3.1	2	3.2		3.6	6	2.8	11	1.6	22	0.9	33	0.6	44	0.5	56	0.5	67	0.4	89	0.4	111	0.4
16	1	15	2.2	18	2.1	23	2.0	28	2.0	33	2.1	43	2.4	84	1.9	167	1.0	251	0.7	335	0.6	419	0.5	502	0.4	670	0.3	.....	.....
	1¼	4	2.9	5	2.8	6	2.6	8	2.6	9	2.8	14	3.0	28	2.0	55	1.1	83	0.8	110	0.5	138	0.5	166	0.5	221	0.4	276	0.4
	1½	2	3.3	2	3.2	3	3.1	4	3.1	4	3.4	7	3.3	15	2.0	30	1.1	44	0.7	59	0.6	74	0.5	89	0.5	118	0.4	148	0.4
20	1¼	6	2.9	7	2.8	9	2.6	11	2.7	13	2.8	17	3.3	35	2.4	69	1.4	104	0.9	138	0.7	173	0.6	208	0.5	277	0.4	346	0.4
	1½	3	3.4	3	3.2	4	3.1	5	3.1	6	3.2	9	3.6	19	2.5	37	1.4	56	1.0	75	0.8	93	0.6	112	0.6	149	0.5	186	0.4
	2	1	4.2	1	4.1	1	4.0	2	4.0	2	4.3	3	3.9	7	2.6	14	1.4	21	1.1	28	0.8	35	0.7	41	0.6	55	0.5	69	0.5
30	1½	6	3.2	7	3.3	9	3.2	11	3.1	13	3.1	17	3.6	28	3.2	56	1.9	84	1.4	111	1.0	139	0.9	167	0.8	223	0.6	278	0.5
	2	2	4.3	2	4.1	3	4.0	3	4.0	4	4.1	5	4.7	10	3.5	21	2.0	31	1.3	41	1.1	52	0.8	62	0.8	83	0.7	103	0.6
	2½	1	5.2		4.9	1	4.7	1	4.7	2	5.0	3	5.5	5	3.8	10	2.1	15	1.4	20	1.1	25	1.0	30	0.8	40	0.7	50	0.7
40	1½	10	3.5	12	3.4	15	3.2	18	3.1	21	3.1	27	3.4	38	3.6	74	2.4	111	1.8	148	1.4	186	1.1	223	0.9	297	0.7	371	0.6
	2	3	4.4	4	4.2	5	4.1	6	4.0	7	4.1	8	4.6	14	4.1	27	2.6	40	1.8	54	1.4	67	1.2	81	1.0	108	0.8	135	0.7
	2½	1	5.2	2	5.0	2	4.8	2	4.7	3	4.8	4	5.7	7	4.2	13	2.7	20	1.9	27	1.4	34	1.2	40	1.0	54	0.8	67	0.7
50	2	5	4.5	5	4.3	7	4.1	8	4.0	9	4.0	12	4.4	17	4.7	34	2.9	52	2.2	69	1.8	86	1.4	103	1.2	138	0.9	172	0.8
	2½	2	5.4	2	5.1	3	4.9	3	4.8	4	4.7	5	5.5	8	5.1	17	3.2	25	2.4	33	1.8	42	1.4	50	1.3	66	1.0	83	0.8
	3	1	6.5	1	6.1	1	5.9	1	5.9	1	6.0	2	7.3	4	5.6	7	3.4	11	2.3	14	1.8	18	1.5	22	1.3	29	1.1	36	0.9
60	2	7	4.5	7	4.3	9	4.1	11	4.0	13	4.0	17	4.5	21	5.0	41	3.5	62	2.6	83	2.0	104	1.7	124	1.4	166	1.1	207	0.9
	2½	3	5.4	3	5.1	4	5.0	5	4.7	6	4.7	7	5.3	10	5.5	20	3.9	30	2.7	40	2.1	50	1.7	60	1.4	80	1.1	101	1.0
	3	1	5.8	1	6.4	1	6.0	2	5.9	2	6.1	3	7.1	4	6.2	8	3.9	13	2.8	17	2.1	21	1.7	25	1.5	34	1.2	42	1.0
80	2	11	4.7	13	4.4	15	4.3	18	4.1	22	4.0	28	4.1	34	4.8	55	4.1	82	3.3	109	2.6	137	2.2	164	1.8	219	1.2	273	1.2
	2½	5	5.5	5	5.2	7	4.9	8	4.8	9	4.7	12	5.0	15	5.8	27	4.5	41	3.5	54	2.7	68	2.2	81	1.9	108	1.4	135	1.2
	3	2	6.7	2	6.4	2	6.1	3	5.9	3	5.9	4	6.5	6	7.1	11	4.9	17	3.6	23	2.8	28	2.2	34	1.9	45	1.5	57	1.3
100	2½	7	5.6	8	5.4	10	4.9	11	4.9	14	4.7	18	4.9	23	5.5	34	5.0	51	4.0	63	3.2	84	2.6	101	2.3	135	1.7	169	1.4
	3	2	6.9	3	6.5	3	6.1	4	5.9	5	5.9	6	6.1	8	7.3	14	5.7	21	4.2	28	3.3	35	2.8	42	2.2	56	1.8	70	1.5
	4	1	8.8	1	8.4	1	8.1	1	7.7	1	7.7	2	8.5	2	9.1	5	6.1	7	4.5	9	3.5	12	2.8	14	2.4	19	1.9	24	1.6
120	2½	10	5.6	11	5.4	13	5.0	16	4.9	19	4.7	24	4.7	29	5.2	40	5.5	61	4.5	81	3.7	101	3.1	121	2.7	162	2.1	202	1.7
	3	3	6.9	4	6.6	5	6.2	6	4.1	7	5.9	9	6.0	11	6.9	17	5.8	25	4.9	33	4.3	42	3.3	50	2.8	67	2.1	84	1.7
	4	1	8.8	1	8.5	1	8.1	2	7.8	2	7.7	2	8.3	3	9.7	6	7.0	9	5.2	11	4.1	14	3.3	17	2.8	23	2.2	29	1.8
140	2½	13	5.7	15	4.6	18	5.1	21	4.9	25	4.8	32	4.7	38	5.1	47	5.9	70	4.7	93	4.2	116	3.6	139	3.1	186	2.4	232	1.9
	3	5	7.0	5	6.7	6	6.2	7	6.1	9	5.9	11	5.9	14	6.5	20	6.7	30	5.3	39	4.5	49	3.7	59	3.2	79	2.4	98	2.0
	4	1	9.0	1	8.5	2	8.1	2	7.9	3	7.7	3	8.1	4	9.3	7	7.7	10	6.0	13	4.7	17	3.8	20	3.2	27	2.5	33	2.1
160	3		7.1	7	6.7	8	6.3	9	6.1	11	5.9	14	5.9	17	6.4	23	7.1	34	5.9	45	4.9	56	4.2	68	3.6	90	2.8	113	2.2
	4	2	9.1	2	8.6	2	8.1	3	7.9	3	7.7	4	7.9	5	8.9	8	8.2	11	6.5	15	5.2	19	4.3	23	3.7	30	2.8	38	2.3
	5	1	11.2	1	10.7	1	10.1	1	9.8	1	9.7	1	10.2	2	12.1	3	9.1	5	7.0	6	5.4	8	4.4	9	3.7	12	2.9	15	2.4
180	3	7	7.1	8	6.8	10	6.4	11	6.1	14	5.9	18	5.9	21	6.3	25	7.4	38	6.0	50	5.3	63	4.6	75	3.9	100	3.1	126	2.5
	4	2	9.2	2	8.7	3	8.1	3	8.0	4	7.7	5	7.8	6	8.6	9	8.7	13	7.0	17	5.8	21	4.8	26	4.1	34	3.1	43	2.5
	5	1	11.3	1	10.7	1	10.1	1	9.9	1	9.7	2	10.7	2	11.8	3	9.8	5	7.6	7	6.0	9	4.8	10	4.2	14	3.2	17	2.6
200	3	9	7.3	10	6.8	12	6.4	14	6.1	17	6.0	21	5.9	25	6.2	31	7.2	42	6.5	56	5.7	70	4.9	84	4.3	112	3.4	141	2.8
	4	2	9.2	3	8.7	3	8.2	4	8.1	5	7.7	6	7.7	7	8.5	10	9.1	14	7.5	19	6.3	24	5.2	29	4.5	38	3.4	48	2.8
	5	1	11.4	1	10.9	1	10.1	1	9.9	2	9.7	2	9.9	2	11.4	4	10.3	6	8.2	8	6.5	10	5.5	12	4.6	15	3.5	19	2.9
240	4	3	9.4	4	8.9	4	8.4	5	8.1	6	7.8	8	7.7	10	8.3	12	9.7	17	8.2	23	7.0	29	6.1	34	5.2	46	4.1	57	3.3
	5	1	11.5	1	11.1	2	10.3	2	10.1	2	9.7	3	9.7	3	10.7	5	11.2	7	9.1	9	7.6	11	6.3	14	5.4	18	4.1	23	3.4
	6	1	13.7	1	13.0	1	12.2	1	11.9	1	11.6	1	11.9	1	13.5	2	12.8	3	9.7	4	7.8	6	6.5	7	5.5	9	4.2	11	3.5
280	4	4	9.4	5	9.0	6	8.4	7	8.1	8	7.9	11	7.7	13	8.1	15	9.3	20	8.9	27	7.7	33	6.7	40	6.0	53	4.7	67	3.8
	5	2	11.7	2	11.1	2	10.4	2	10.1	3	9.7	3	9.7	4	10.4	5	11.9	8	9.9	11	8.4	15	7.2	16	6.2	21	4.8	27	3.9
	6	1	13.9	1	13.2	1	12.1	1	12.1	1	11.6	2	11.7	2	12.9	3	13.3	4	10.8	5	9.0	6	7.4	8	6.4	10	4.8	13	4.0

*Equivalent number of feet of straight pipe to add for each 90° elbow.

This table shows HEAD (in feet of water) necessary to force liquids of different viscosities and specific gravity of unity and in given quantities, through 100 ft. of clean, new wrought iron pipe.

If liquid has a specific gravity other than unity, consider—

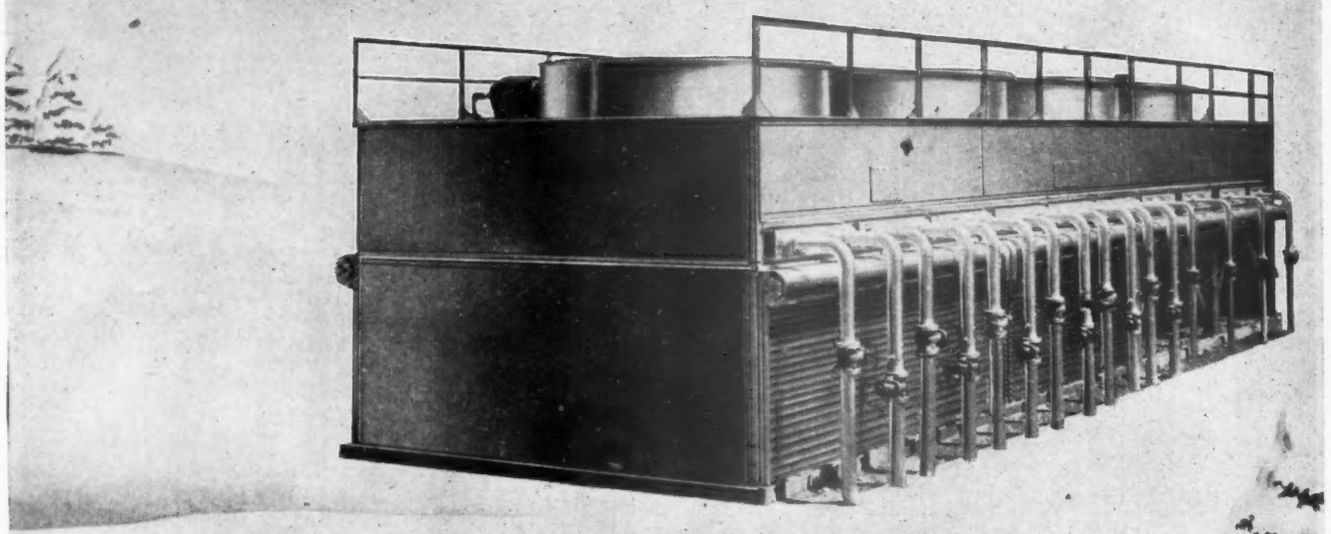
1. If viscosity is in Engler, Redwood or Saybolt multiply friction head shown by the specific gravity. This will give you friction head in feet of water corrected for specific gravity.

2. If viscosity is in centipoises, divide the centipoises by specific gravity and use the result in the line marked "centipoises" to find the friction head. Now multiply the friction head by the specific gravity. This will give you friction head in feet of water corrected for specific gravity.

(Data supplied by Geo. D. Roper Corporation)

MARLEY DRICOOLERS®

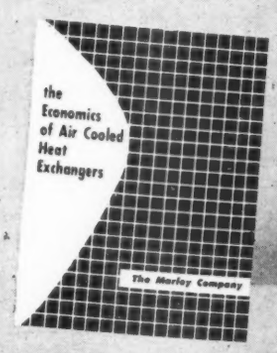
take winter in stride...



Maintaining correct process temperatures in all kinds of weather . . . that is the job DriCooler air cooled heat exchangers are engineered to do and they do it! How well they do it is best attested by the experience of DriCooler operators in the Northwest and other sections of the country where sub-zero temperatures are common.

These operators know that DriCoolers in their plants are engineered for any conditions the elements offer. They know that at 30 and 40 degrees below zero there will be no days or nights of intense effort to keep plants running in spite of frozen tube sections, fan icing or other winter-caused difficulties. All have full confidence that their plants will go on delivering gas or electricity in a smooth routine manner because they have the benefit of Marley's broad experience in designing DriCoolers to meet frigid conditions.

Marley engineering gives as much consideration to low temperatures as to high temperatures. Marley uses (and uses correctly) the most modern techniques to aid the operator in maintaining design temperatures the year round. DriCooler induced draft design protects tube sections by placing them below the plenum chamber where they are not exposed. It keeps the fan in the warm air stream where it cannot accumulate ice. Add to this the control of intake air by easy rolling steel doors or by multi-vane shutters and you have the one air cooled heat exchanger that knows no climatic barriers . . . you have the Marley DriCooler.



Write for a copy of this brochure. It gives very complete information on application of DriCoolers in YOUR business. Address Department DC2.

MARLEY

The Marley Company

Kansas City 5, Missouri

SOLUTION OF HAZEN AND WILLIAMS FORMULA FOR LARGE CAPACITY LINES

FORMULA:—

$$p^{0.54} = \frac{162.04\ Q^{1.84}}{cd^{2.63}}$$

Where
P = Pounds per sq. in. friction loss per mile
Q = Discharge in bbls. per hour
g = Specific gravity
d = Inside diameter of pipe in inches

Examples:.

(1) Given: To transport 20,000 Bbls. of 60° Be' gravity gasoline thru 8" line pipe having a roughness coefficient C = 145

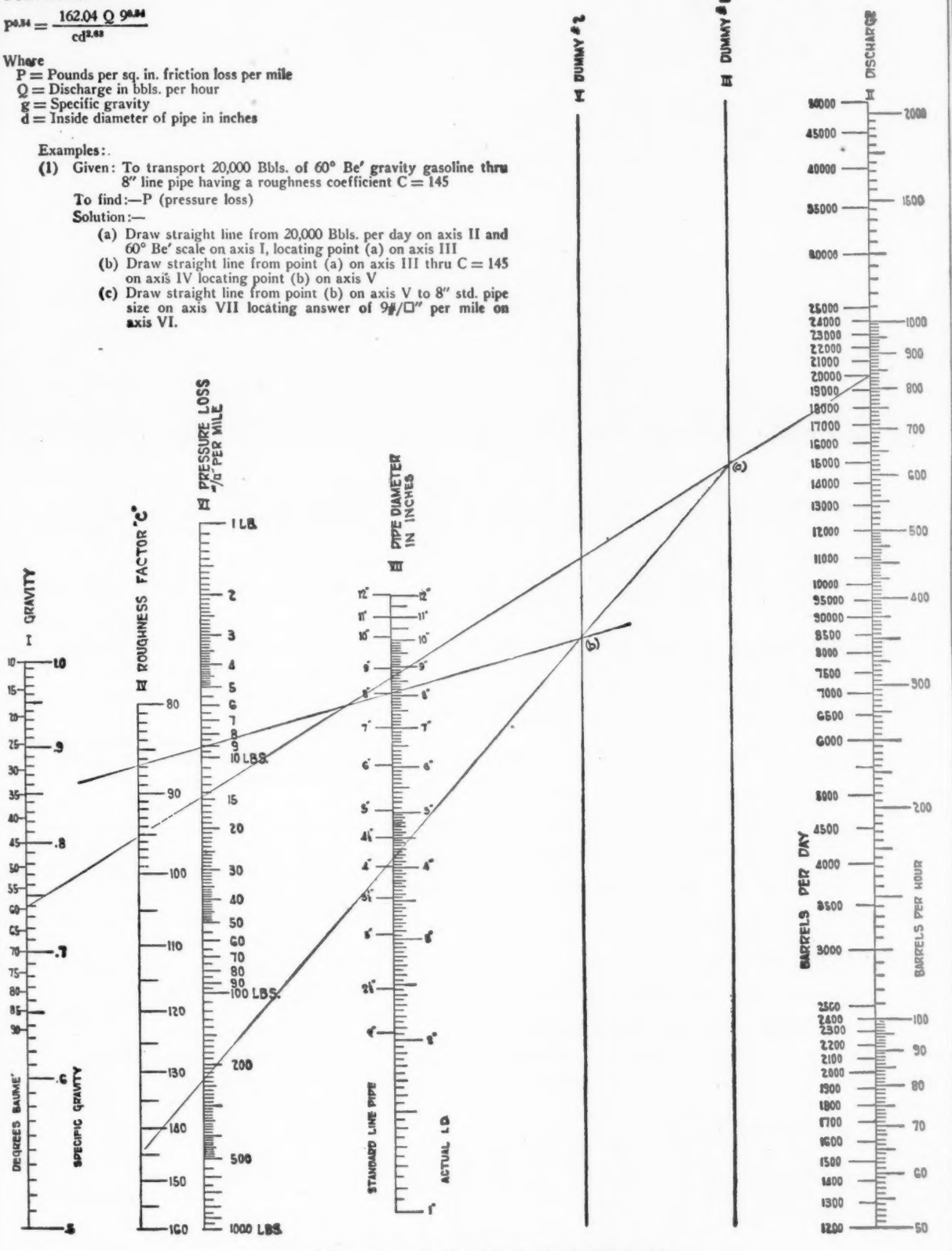
To find:—P (pressure loss)

Solution:—

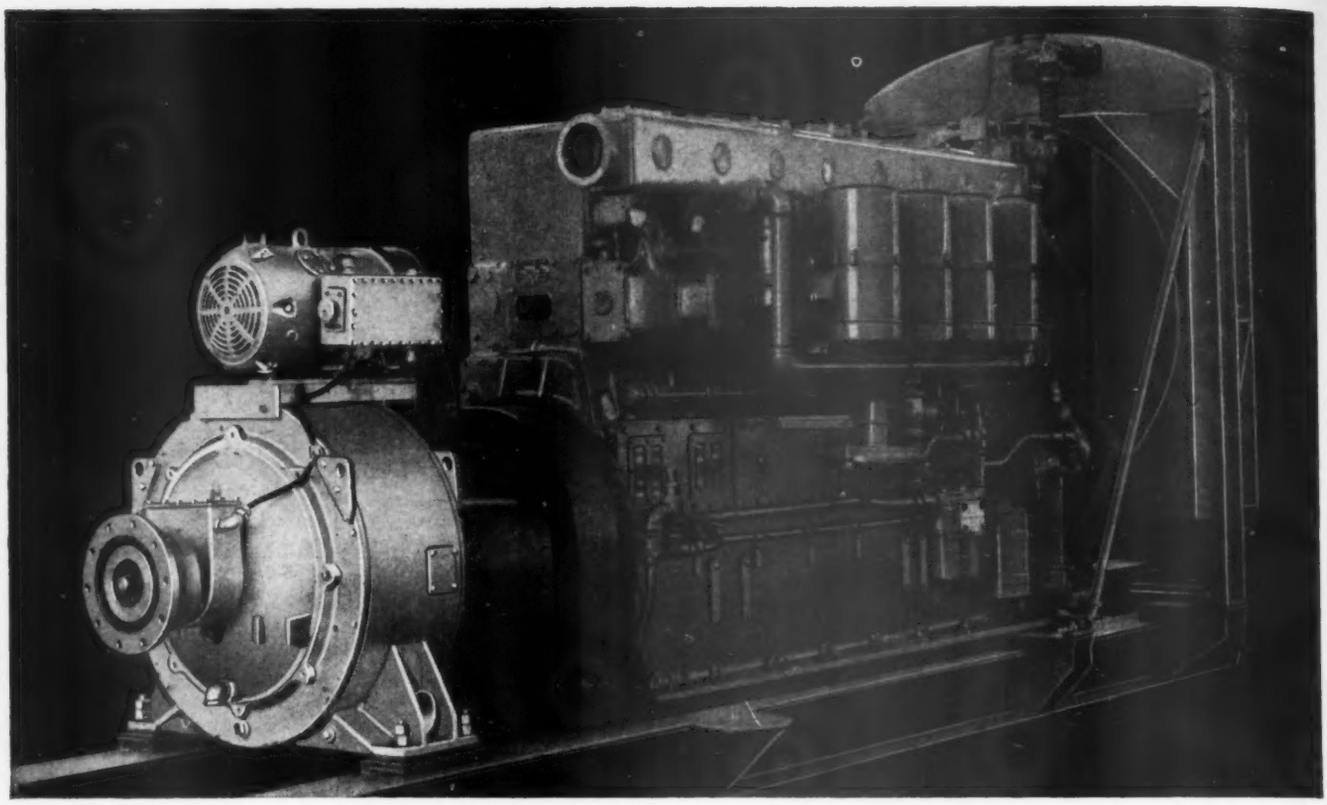
(a) Draw straight line from 20,000 Bbls. per day on axis II and 60° Be' scale on axis I, locating point (a) on axis III

(b) Draw straight line from point (a) on axis III thru C = 145 on axis IV locating point (b) on axis V

(c) Draw straight line from point (b) on axis V to 8" std. pipe size on axis VII locating answer of 9#/□" per mile on axis VI.



Reproduced by permission of The Natural Gasoline Supply Men's Association



Dynamatic Water-Cooled Couplings for Rig Drives

Adjustable from 2% to 100% Slip in Continuous Operation

Instantaneous Control • No Friction or Wear

The new Dynamatic electro-magnetic Coupling replaces the friction clutch. Slip is adjustable from 100% to less than 2%. Water cooling permits continuous operation at 100% slip with full torque. Explosion-resistant construction. Available in convenient sizes for oil field engines from 350 to 750 horsepower.

Write for technical literature.

Oil Industry Sales and Service Representatives

GRIBBIN & BAYLOR

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Houston 3, Texas

529 General Petroleum Building
Los Angeles 17, California

Advantages of Dynamatic Couplings

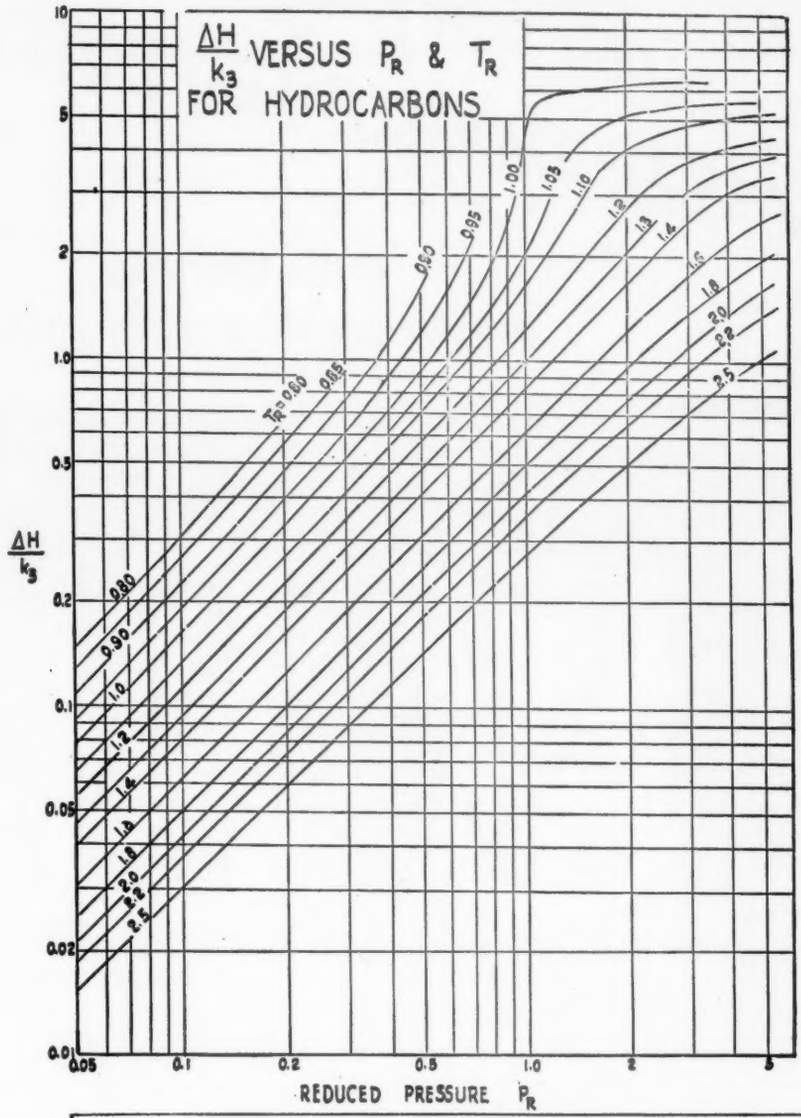
- Engines are automatically brought to operating speed before load is applied.
- Serves as disconnect clutch.
- Infinitely variable torque and speed to rotary table.
- Pump speed and pressure controllable and pump can be stalled continuously at maximum pressure.
- Permit continual raising and lowering of pipe at full engine speed without use of clutch or brake.
- Engines cannot be stalled or loaded at idling speed.
- Master and individual controls give instantaneous response.
- Absorbs engine vibrations and shocks of suddenly applied loads.
- Uses conventional water system with simple connections.
- Has quick-disconnect electrical connections for easy portability.
- No wearing surfaces except bearings.

DYNAMATIC® CORPORATION • KENOSHA WISCONSIN

Subsidiary of EATON MANUFACTURING COMPANY, Cleveland, Ohio

Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls

HYDROCARBON THERMODYNAMICS



This series of tables is based on the articles on "Hydrocarbon Thermodynamics." by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 10 (left) is a generalized plot of the isothermal correction to the enthalpy of vapors as a function of reduced temperature and pressure.

Table 4 (below) shows the phase equilibrium relationships for ideal and non-ideal solutions.

PHASE EQUILIBRIUM

VAPOR PRESSURE RELATIONSHIP

COMBINING DALTON'S LAW, $p = Py$ AND RAOULT'S LAW, $p = \pi X$ GIVES

$p = \pi X = Py$ } VALID ONLY AT LOW PRESSURES FOR IDEAL SOLUTIONS

$K = \frac{Y}{X} = \frac{\pi}{P}$ }

K = EQUIL. PHASE DISTRIBUTION CONST.

X, y = MOL FRACT. IN LIQ. & VAP.

p, π, P = PARTIAL, VAPOR AND TOTAL PRESSURES

FUGACITY – ESCAPING TENDENCY

FOR PERFECT GAS

$$\Delta F_T = RT \ln \frac{P_2}{P_1}$$

FOR ACTUAL GAS

$$\Delta F_T \; RT \ln \frac{f_2}{f_1}$$

WHERE f IS THE FUGACITY, WHICH IS DEFINED TO REPLACE PRESSURE, FROM WHICH

$$RT \ln \frac{f}{P} = -\int_0^P \alpha \, dP$$

WHERE $\alpha = V - \frac{RT}{P}$

FUGACITY EQUILIBRIUM RELATIONSHIPS

IDEAL SOLUTIONS – FUGACITY OF EACH COMPONENT IS PROPORTIONAL TO ITS MOL FRACTION AT EVERY TEMPERATURE & PRES.

$$f_L X = f_V Y$$

$$K = \frac{Y}{X} = \frac{f_L}{f_V} = \left(\frac{f\pi/\pi}{f_P/P}\right)\frac{\pi}{P}$$

$f_L = f_\pi$ = FUGACITY OF PURE COMPONENT IN LIQUID PHASE OR AT THE VAPOR PRESSURE, π.

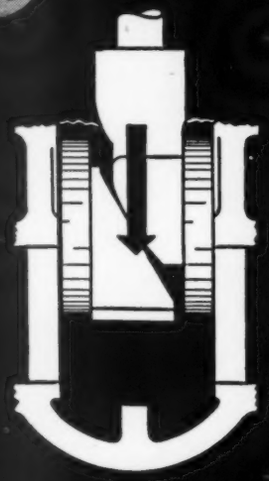
$f_V = f_P$ = FUGACITY OF PURE COMPONENT IN VAPOR PHASE OR AT THE TOTAL PRESSURE, P.

NON-IDEAL SOLUTIONS — FUGACITIES OF COMPONENTS IN BOTH LIQUID AND VAPOR PHASES ARE FUNCTIONS OF TEMP., PRES., AND PHASE COMPOSITIONS

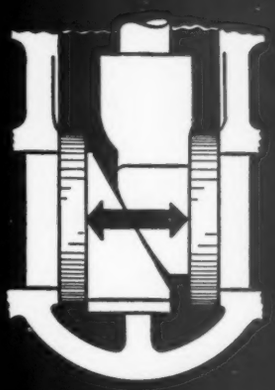
1. PHASE DIAGRAM METHOD
2. EQUIL. BOMB METHOD
3. CONVERGENCE PRESSURE
4. EQUATION OF STATE METHOD

Look how you gain LONGER, TROUBLE-FREE VALVE LIFE

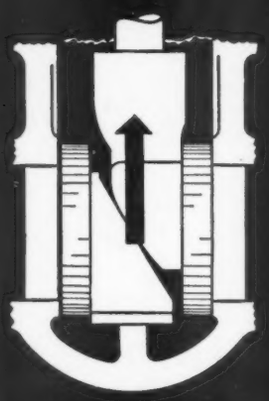
with Darling revolving disc gate valves*



DESCENDING. Fully revolving discs, independently hung, change seating position at each closing, assuring uniform wear distribution for prolonged service. Plain "no pocket" discs are interchangeable for *extra* life!



CLOSED. Faces of upper wedge are radiused and faces of both wedges are transversely beveled for equalized wedging pressure and *tight closing despite valve body distortion.*



RISING. Wedging pressure on both discs is released before discs start to rise. Complete absence of wedging pressure during travel of discs assures easy operation, tight closing and greatly prolonged valve life!

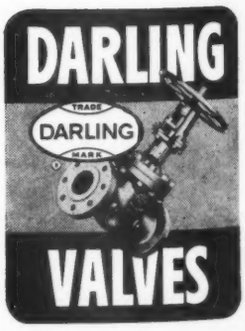
***DARLING REVOLVING DISC GATE VALVES FOR EVERY NEED . . .**

These unique valves are available in iron, bronze, steel, special corrosion-resistant alloys and combinations, and in a broad range of sizes, for all kinds of normal and unusual services in pressures up to 1500 pounds. Before you buy gate valves of *any* type, find out what you stand to gain by using the proper Darling valves. Simply outline your service requirements and ask for a free, descriptive bulletin.

DARLING VALVE & MANUFACTURING CO.

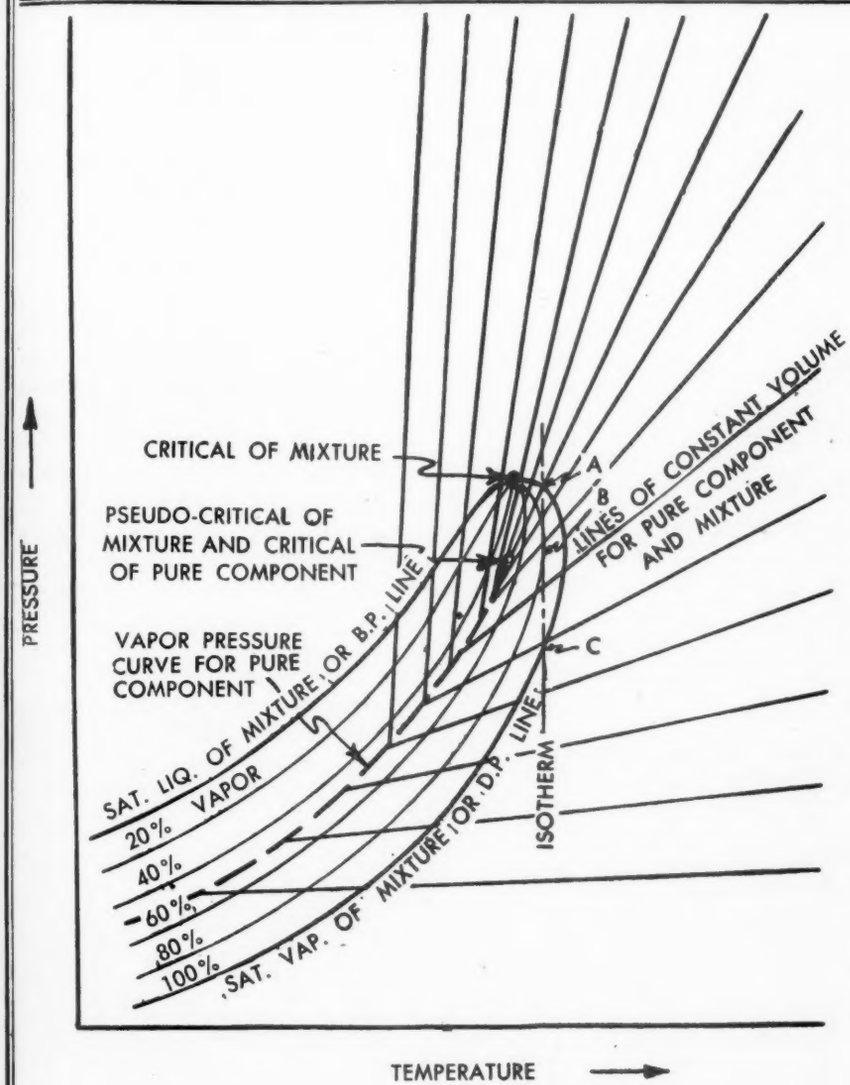
Williamsport 2, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario.



FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

HYDROCARBON THERMODYNAMICS

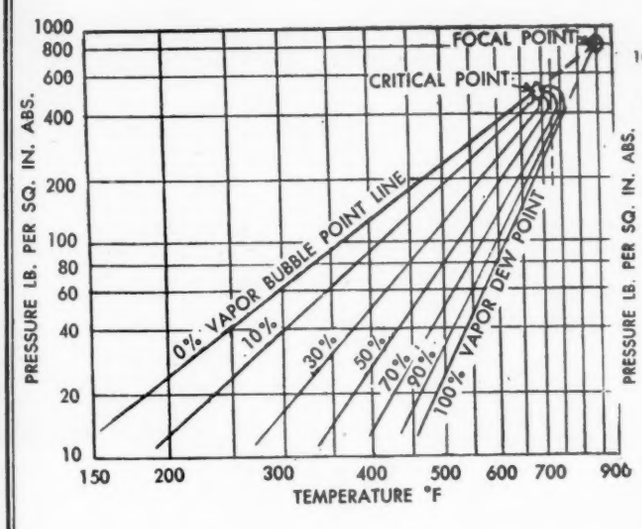


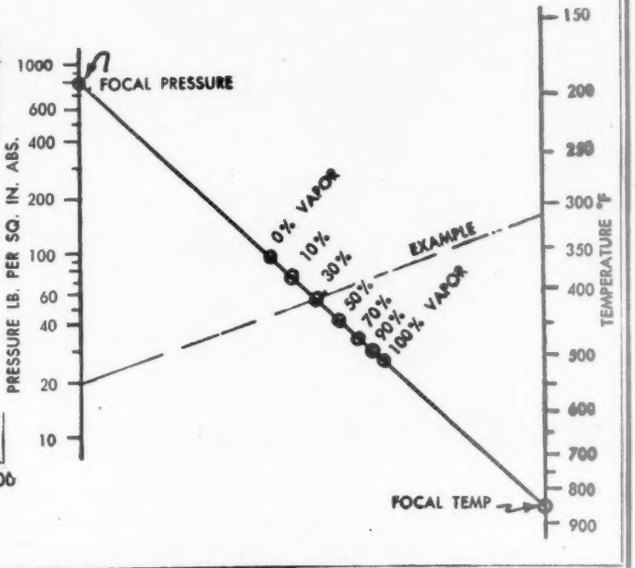
This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 2 (left) is a pressure-temperature diagram of a pure component and a mixture of hydrocarbons illustrating the pseudocritical concept and retrograde phenomena. Note that the pressure vs. temperature plot for the mixture consists of two lines that join at the critical point. *Reference:* Kay, W. B., *Ind. & Eng. Chem.* Vol. 28, p. 1014 (1936). "Density of Hydrocarbon Gases and Vapors."

Fig. 3 (lower left) is a phase diagram of naphtha-kerosine plotted on log-log graph paper. *Reference:* Katz, D. L., and Brown, G. G., *Ind. & Eng. Chem.* Vol 29. p. 1408 (1937), "Vapor Pressure and Vaporization of Petroleum Fractions."

Fig. 4 (lower right) is a phase diagram of naphtha-kerosine plotted as an alignment chart.





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another important story about

4-CYCLE V-ANGLE COMPRESSORS

Repeated installations of Ingersoll-Rand Gas-Engine Driven Compressors keep pace with steady growth of Lloyd Corporation, Ltd. of California Gas Booster plant

When Lloyd Corporation, Ltd. back in '42, built its booster plant in Ventura, Cal., it selected a 300-hp Ingersoll-Rand XVG compressor for gas-lift service. The XVG had revolutionized oilfield practices when it was introduced in 1933 as the first V-angle gas-engine-driven compressor, and had quickly achieved world fame and acclaim for its outstanding performance in all kinds of services.

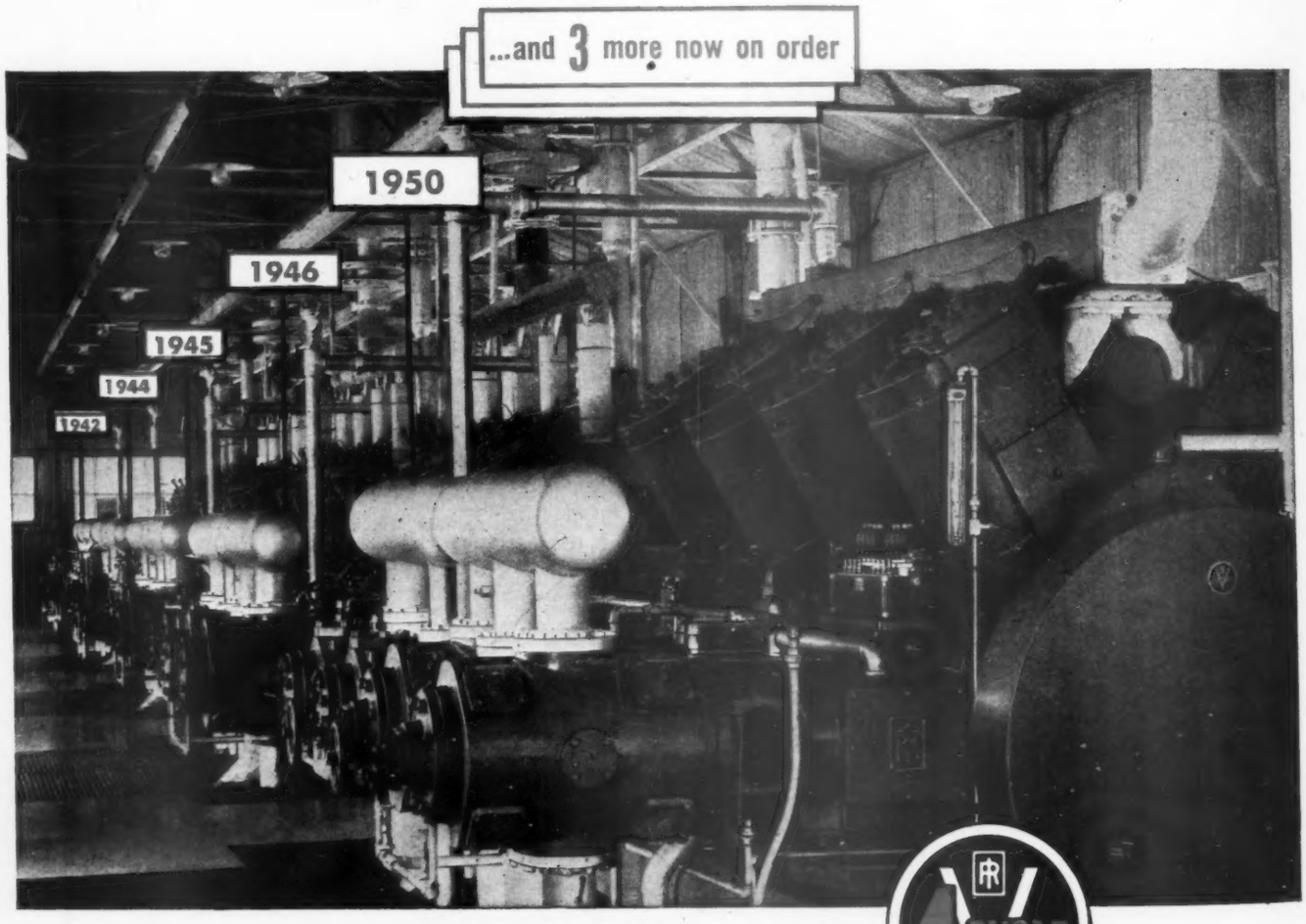
After two years' first-hand experience with its XVG, Lloyd installed another one . . . and additional units in '45 and '46.

Then in 1950 it purchased a different compressor. This machine was also an Ingersoll-Rand, and fit into the same amount of space . . . had the same number of cylinders. And it had all of the important, proven, and desirable features of the XVG.

But it had 45% more capacity. It incorporated many new and advanced design features that make it an even better machine. This was the modern design of the famous XVG. It is known as the SVG . . . made in three sizes, 330, 440 and 550 horsepower.

Lloyd liked the SVG, too. They ordered three more, two for '52 and one for delivery in early '53.

Let your I-R representative tell you more about the SVG and the other units in the full line of Ingersoll-Rand 4-cycle gas engines and compressors.



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COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

METHOD OF DETERMINING NUMBER OF PLATES FOR A RECTIFYING COLUMN

Fig. 1 represents an expansion of the familiar McCabe-Thiele diagram. Within square OPQR are represented equilibrium curve ODQ and two operating lines AK and BD. Extension of the equilibrium curve and rectifying line to the right to the point of intersection at I permits the construction of rectangle HIJK, within which are represented the operating conditions of the section of the column above the feed plate. The rectifying line is the diagonal of this rectangle; this suggests that the upper part of the column is apparently operating at total reflux.

Points (x_0, y_0) and (x_E, y_E), the intersections of the operating line and the equilibrium curve, may be located by solving simultaneously the equation of the operating line, $y = mx + c$, and the equilibrium relation, $y(1-x)/x(1-y) = a$, obtaining: $m(a-1)x^2 + (m - a + ac - c)x + c = 0$ and $(a-1)y^2 + (m - a - ac + c)y + ac = 0$. The solution of these quadratics for x_0, x_E, y_0, and y_E is obviously somewhat involved and leads to cumbersome expressions. However, the products x_0x_E and y_0y_E are useful and are simply stated: $y_0y_E = ac/(a-1)$ and $x_0x_E = c/m(a-1)$. Dividing these equations and rearranging gives $y_0y_E/ax_0x_E = m$, and, since $m = (y_E - y_0)/(x_E - x_0)$,

$$(y_E - y_0)/(x_E - x_0) = y_0y_E/ax_0x_E \quad . . . . . (1)$$

Consider the arc cut by a straight line through points (x_0, y_0) and (x_1, y_1). From analogy to Equation 1 this leads to

$$(y_1 - y_0)/(x_1 - x_0) = y_1y_0/ax_1x_0 \quad . . . . . (2)$$

and, for the straight line through points (x_1, y_1) and (x_E, y_E),

$$(y_E - y_1)/(x_E - x_1) = y_1y_E/ax_1x_E \quad . . . . . (3)$$

Dividing Equation 2 by Equation 3 gives

$$\frac{(y_1-y_0)\ (x_E-x_1)}{(x_1-x_0)\ (y_E-y_1)} = \frac{y_0x_E}{x_0y_E} \quad . . (4)$$

which represents ratios of slopes from the top plate to opposite corners of the rectangle.

A ratio around point (x_2, y_2) results in the expression

$$\frac{(y_2-y_0)\ (x_E-x_2)}{(x_2-x_0)\ (y_E-y_2)} = \frac{y_0x_E}{x_0y_E} \quad . . (5)$$

A similar expression may be written for each plate above the feed plate. The product of all these expressions leads to the series

$$\frac{(y_1-y_0)\ (x_E-x_1)}{(x_1-x_0)\ (y_E-y_1)}\cdot\frac{(y_2-y_0)(x_E-x_2)}{(x_2-x_0)(y_E-y_2)}\cdot\frac{(y_3-y_0)}{(x_3-x_0)}\cdots\frac{(y'_q-y_0)\ (x_E-x_q)}{(x_q-x_0)\ (y_E-y'_q)} = \left(\frac{y_0x_E}{x_0y_E}\right)^{n_1} \quad . . . . . (6)$$

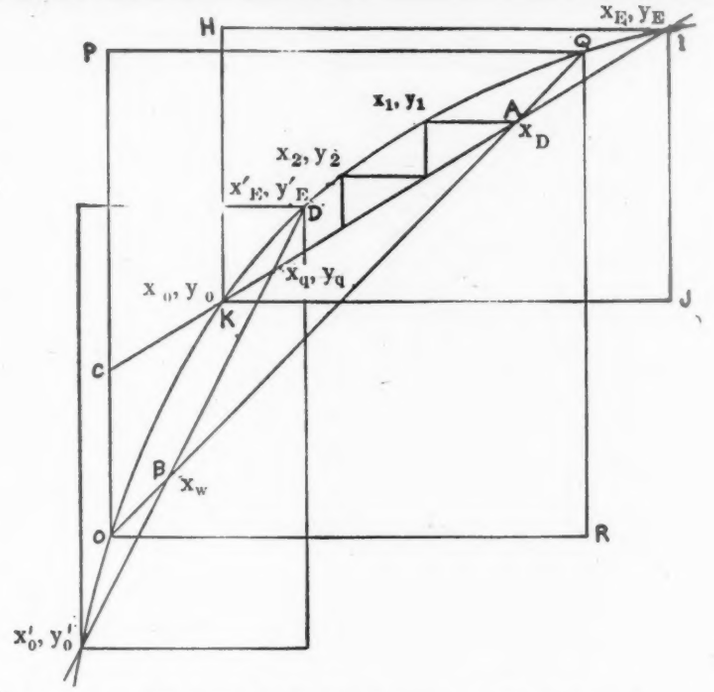


FIG. 1. Modified McCabe-Thiele diagram for distillation column.

In Fig. 1 point (x_1, y_2) falls on the diagonal of the rectangle. It is obvious from the geometrical construction that area $(x_E - x_1)\ (y_2 - y_0) =$ area $(y_E - y_2)\ (x_1 - x_0)$. Also $(x_E - x_2)\ (y_3 - y_0) = (x_2 - x_0)\ (y_E - y_3)$, etc. Cancellation of these equalities from Equation 6 gives

$$\frac{(y_1-y_0)\ (x_E-x_q)}{(y_E-y_1)\ (x_q-x_0)} = \left(\frac{y_0x_E}{x_0y_E}\right)^{n_1} \quad (7)$$

which is a general equation for calculating the number of plates above the feed plate.

For conditions below the feed plate the equilibrium curve is extended below the origin to permit intersection with the stripping line at points (x'_E, y'_E) and (x'_0, y'_0). A rectangle is constructed with these points on the diagonal. The derivation of the equation for the number of plates below the feed plate is entirely analogous to that given and result in the equation

$$\frac{(y_q-y'_0)\ (x'_E-x_w)}{(y'_E-y_q)\ (x_w-x'_0)} = \left(\frac{y'_0x'_E}{x'_0y'_E}\right)^{n_2} \quad . . . . . (8)$$

The total number of plates required for the entire column is the sum of n_1 and n_2 where n_2 includes the still pot as one of the plates in the stripping section.

Equations 7 and 8 are algebraically identical to those proposed by Smoker, although the similarity is by no means obvious. When this derivation is applied to conditions at total reflux, the equation reduces to

$$y_1(1 - x_w)/x_w(1 - y_1) = a^n,$$

as given by Fenske.

Nomenclature

- x = mole fraction of more volatile component in liquid,
- y = mole fraction of more volatile component in vapor,
- y_1 = mole fraction of more volatile component in overhead product,
- x_w = mole fraction of more volatile component in waste,
- a = relative volatility,
- m = slope of rectifying line,
- c = y-intercept of rectifying line on x, y diagram when $x = 0$,
- x_0, y_0 = lower point of intersection of rectifying line and equilibrium curve,
- x_E, y_E = upper point of intersection of rectifying line and equilibrium curve,
- x'_0, y'_0 and x'_E, y'_E = lower and upper points of intersection of stripping line and equilibrium curve, respectively,
- x_q, y_q = point of intersection of rectifying and stripping lines,
- y_q' = equilibrium value of y when $x = x_q$,
- n_1 = number of theoretical plates for rectifying section,
- n_2 = number of theoretical plates for stripping section.

Taken from the article, "Calculation of number of theoretical plates for rectifying column," by A. E. Stoppel, published in *The Petroleum Engineer*, Reference Annual, 1947. pages 189 and 190.

LAUGH with BARNEY

A kind-hearted lady who had strict ideas about the consumption of strong drink, was accosted by a shabby character.

"Please, ma'am," he whined, "can you spare a little cash for a poor, needy fellow?"

The lady hesitated, sniffing. But he was such a pitiful object, that she opened her purse. "Here," she said, handing him some money, "take this, but I hope you won't spend it for vile liquor."

The needy one scanned the frugal handout. "With what you gimme, ma'am," he answered, sadly, "I can't get no other kind."

* * *

"My memory is excellent," said the aging chief. "There are only three things I can't remember. I can't remember names, I can't remember faces, and I can't remember what the third thing is!"

* * *

In an English political meeting one of the candidates patriotically orated: "I was born an Englishman. I have lived an Englishman. I hope I shall die as an Englishman."

From the back of the hall, in an unmistakable accent, came the question, "Mon, hae ye no ambeetion?"

* * *

Money doesn't talk these days—it goes without saying!

The Sunday school class was composed of three-year-olds. The teacher asked:

"Do any of you remember who St. Matthew was?" No answer.

"Well, does anyone remember who St. Mark was?" Still no answer.

"Surely some of you must remember who Peter was?"

Finally a tiny voice from the back of the room:

"I fink he was a wabbit!"

* * *

Thousands of lives have been destroyed by whiskey, but just look at all the boats that have been wrecked by water.

* * *

A cold is both affirmative and negative: sometimes the eyes have it and sometimes the nose.

* * *

Famous Last Words: "Guess what, dear, I sold the baby buggy."

* * *

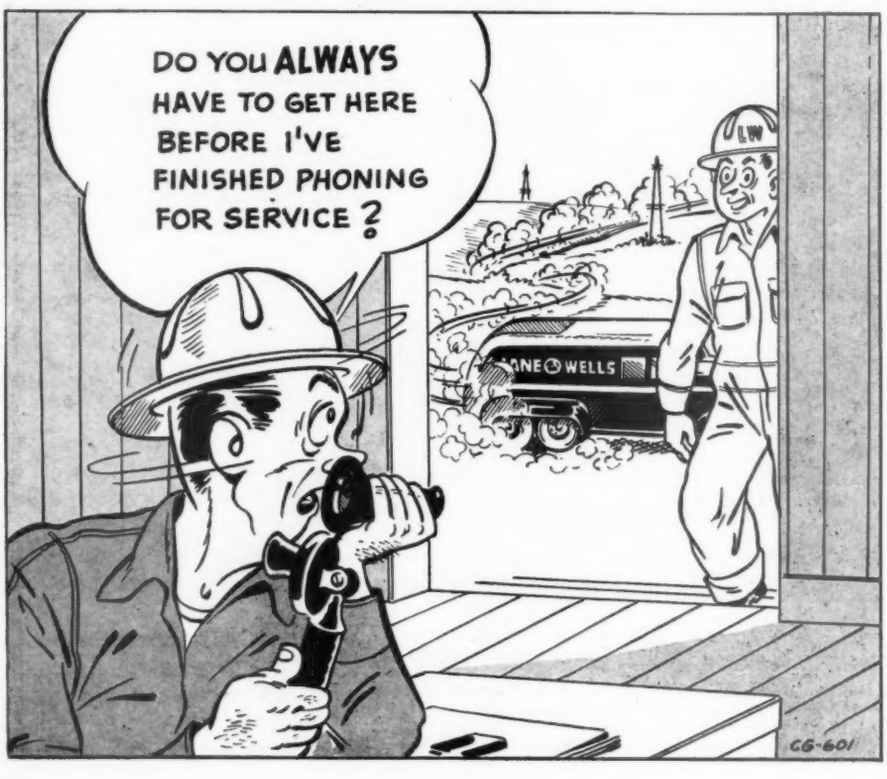
Driver of overturned cab (to Scottish passenger): Are you hurt, sir?

Scot: Don't bother about that mon. Stop that wee clock of yours.

* * *

Porter: "Did you miss your train, Sir?"

Irate Traveler: "No, I didn't like its looks, so I chased it out of the station."



"We are now passing the largest brewery in Milwaukee," exclaimed the guide.

"Not me," said the tourist as he hopped off the bus.

* * *

The two skeletons in the corner closet were grumbling about the heat, the dust, the boredom. "What are we staying here for anyway?" one asked.

"Darned if I know," the second skeleton answered. "I'd leave here in a minute if I had any guts."

* * *

A psychiatrist saw another psychiatrist plodding down the street carrying a couch on his head.

"Why the couch?" he called after his colleague.

"House call," replied the burdened one.

* * *

Pat and Maggie had been driving for almost an hour through a lonely country road. No word had been spoken. The rattle of the car and the hum of the motor was all that broke the stillness. Suddenly Pat looked at Maggie and muttered in a quiet, unemotional voice: "Maggie, will you marry me?"

Maggie, showing some emotion, answered in the affirmative.

The speed of the car was not broken. For the next half hour not a word was spoken.

Growing impatient, Maggie finally looked at Pat and asked: "Pat, ain't you going to say nothing else?"

"Nope," came the answer, "Said too darn much already!"

* * *

While doing his homework one evening, a young lad became puzzled over something, and approached his father for information.

"Daddy," he said, "I have just been studying about a man named Don Quixote, and I don't understand one thing. Why did he go around tilting windmills?"

"Probably because there were no pinball machines in his day," replied his father.

* * *

"I knew them danged scientists would keep foolin' around until they did something they hadn't oughter," stormed the old man from the hills. "Now look what they've gone and did!"

"What's that, Paw?" asked his wife. "You mean the atom bomb?"

"Heck no," exploded the old man. "They've fooled around until now they've discovered something besides likker to cure a cold!"

* * *

Little Willie dashed breathlessly into the drug store.

"Quick!" he panted. "My father's hanging by his pants from a spiked fence."

"What can I do?" asked the druggist.

"Put a new roll in my camera," said Willie.—Sunnen Snooper.

* * *

Shopper: "May I try on that tweed suit in the window?"

Sales person: "Certainly, lady, but we'd rather you used the dressing room."

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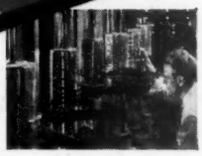

Continuing Study of behavior of metals under stress at high temperatures has produced valuable design data.

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Pneumatic Tool Plant Nears Completion Date

Erection of the first of 400 tons of structural steel for the new Chicago Pneumatic Tool Company is being completed, Walter Kidde Constructors, Inc., engineers and builders, announced. The plant, which will manufacture oil well drilling equipment for the petroleum industry, will contain approximately 140,000 sq ft of floor space. Installation of equipment is expected to begin in February, and preliminary production operations are expected to being by late spring.

Roebling's Sons Stock Sold

A wholly owned subsidiary of The Colorado Fuel and Iron Corporation has contracted to buy all the manufacturing business, plants, and inventories of John A. Roebling's Sons Company. The announcement was made by Charles Allen, Jr., chairman of the board of The Colorado Fuel and Iron Corporation, and Charles R. Tyson, president of Roebling.

The Roebling business will be operated as a subsidiary of Colorado Fuel and Iron under the Roebling name. Tyson, president of Roebling since 1944, will continue to direct the operations of the Roebling plants.

Distributors Named

Globe Steel Tubes Company announced that The Sterling Supply Company, 21 West De La Guerra Street, Santa Barbara, California, has been appointed distributor for Globe seamless welding fittings and flanges. Sterling Supply Company will maintain representative stock of Globe fittings, and prompt shipment can be made.

Motorola Announces New Subsidiary Corporation

Paul V. Galvin, president of Motorola, Inc., has announced the organization of a wholly owned subsidiary corporation, Motorola Communications and Electronics, Inc. The new company will distribute products manufactured by the communications and electronics division of the parent corporation. These products include complete mobile two-way radio systems, multi-channel microwave relay systems, power line carrier, supervisory, and industrial control equipment.

Sales Agents Named

Hammel-Dahl Company announces the appointment of the Control Equipment Company, Atlanta, Georgia, as additional sales and service representatives. This newly formed and aggressive organization will offer the complete sales and service facilities of Hammel-Dahl engineering and products in Georgia, Alabama, and Florida.

Hercules Opens Branch

A new sales and service facilities has been opened by Hercules Motors Corporation in Oklahoma City. The new branch is at 1117 Exchange Avenue, and provides ample space for stocks of Hercules engines and power units available for immediate delivery. Other facilities include a modern service department with an adequate stock of parts, which is maintained at all times, as well as a large, modern, fully equipped machine shop where engines and power units can be economically repaired, overhauled, or rebuilt. The new branch will be under the supervision of J. A. Embry, manager of Hercules oilfield division.

Wiseman Is President Of Fluor of Canada

The Fluor Corporation, Ltd., has announced the activation of the Fluor Corporation of Canada, Ltd., a federal corporation. J. P. Wiseman, who formerly served as vice president and director of sales of the parent company, has been elected president of the Canadian firm. John G. Marshall, formerly chief engineer of the Fluor Corporation, Ltd., has been elected vice president in charge of engineering, and D. H. White from Fluor's Chicago office is being transferred to Toronto and will handle the sale of Fluor's manufactured products throughout Canada. George B. Foster of the legal firm of Foster, Hannen, Watt and Stikeman, Montreal, is a director and also the general counsel for the Canadian affiliate.

J. P. Wiseman

Thew Shovel Film Out

The Thew Shovel Company, Lorain, Ohio, has produced a new 16-mm sound film in color with a screen time of 22 min. The title is "Sidewalk Superintendents of America," and it takes the viewer to jobs all over the country where Lorains are at work. Mountain highways, logging "shows", mines, pipe lines, railroads, dams, buildings, sugar cane fields, scrap yards, and manufacturing plants are shown as scenes of Lorains' labors. There is a short introduction and closing by Thew President, C. B. Smythe on Thew's position in the industry.

Gar Wood Industries, Findlay division district managers and sales personnel attended a two-day shovel sales school at Findlay, Ohio, recently. They are: Back row, E. W. Hazzard, export manager; Gil E. Koehler, district manager; H. N. Nelson, assistant sales manager; W. M. McAllister, district manager; J. Frisby, Spencer Wright; Jim W. Killen, district manager; Harold Clark, district manager; W. C. Schult; Dick Steegman, assistant sales manager; W. C. Robertson, vice president, New York and Washington offices; H. C. Hatch; Dale Ollendorf; Ken Keyes, works manager; A. F. Dries; Jack Nichols; R. S. Jay, Findlay sales manager. First row, W. G. Barrett, district manager; Dave J. Davis, assistant sales manager; Ernie Schulz; G. E. Miller, chief engineer; E. R. Curry, district manager; George Ames, district manager; Allen F. Closser, district manager; Kieth Rowe; R. O. Gerdeman; W. F. Wittenmyer, A. M. Guthrie, district managers; E. B. Hill, vice president, director of sales and advertising.

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WINSLOW,
OF COURSE

WHO SAID IT WOULDN'T WORK?

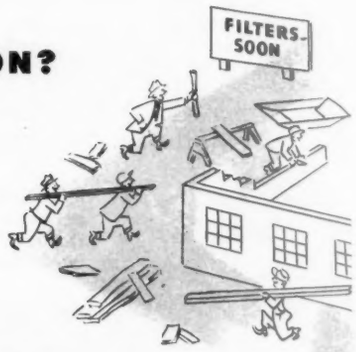
SEVERAL
COMPETITORS

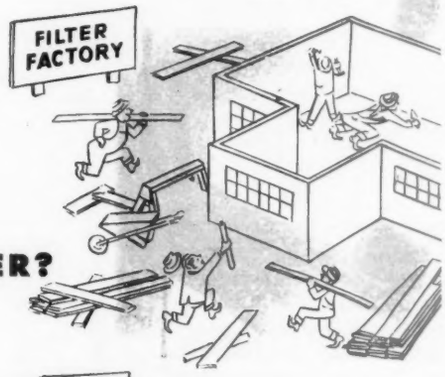
WHO IS NOW FALLING INTO LINE?

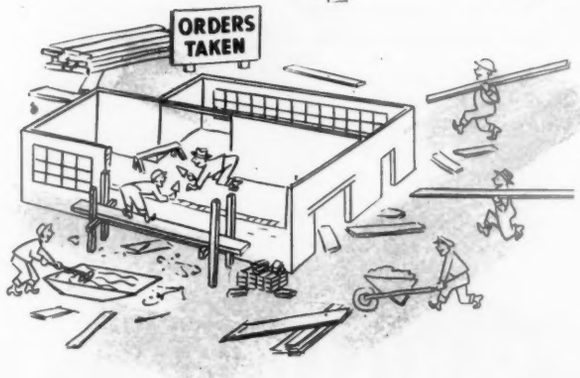
THOSE SAME
COMPETITORS

WHO IS STILL THE NATURAL LEADER?

WINSLOW, OF COURSE







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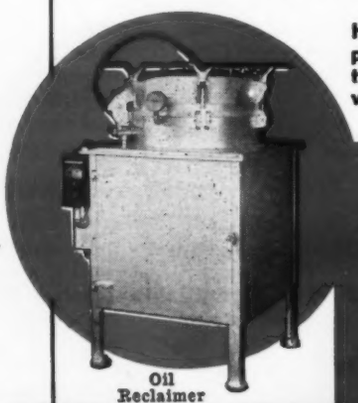
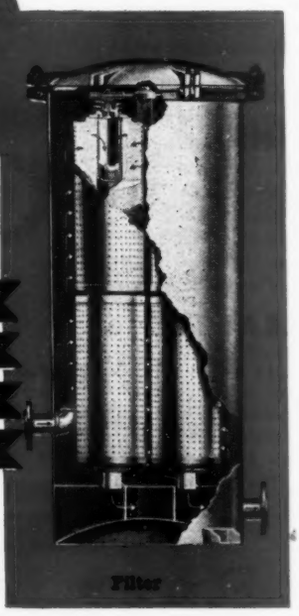


Oil Reclaimer



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Folder Depicts Torrance Plant

Visitors to the Torrance, California, plant of The National Supply Company now receive a 3-color pictorial folder that describes the facilities of the plant and shows its relationshp to the rest of the company. It is folded in such a way that the reader turns from the cover page, depicting the entrance to the plant, to a double page spread showing an airplane view of the plant. This, in turn, opens to a four page spread featuring a map of the United States and Canada, on which are shown the locations of National Supply's home office, its six plants, its 115 supply stores and its sales offices.

Text says that National Supply's plant is generally considered to be the largest completely integrated machinery manufacturing plant in the West. Its 38 acres include 30 principal buildings, with approximately 700,000 square feet of covered floor space.

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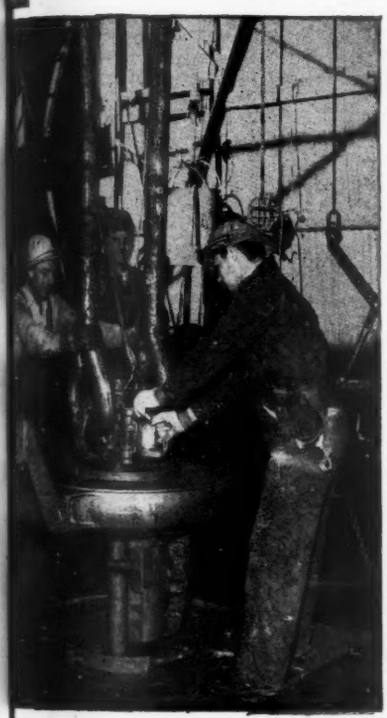

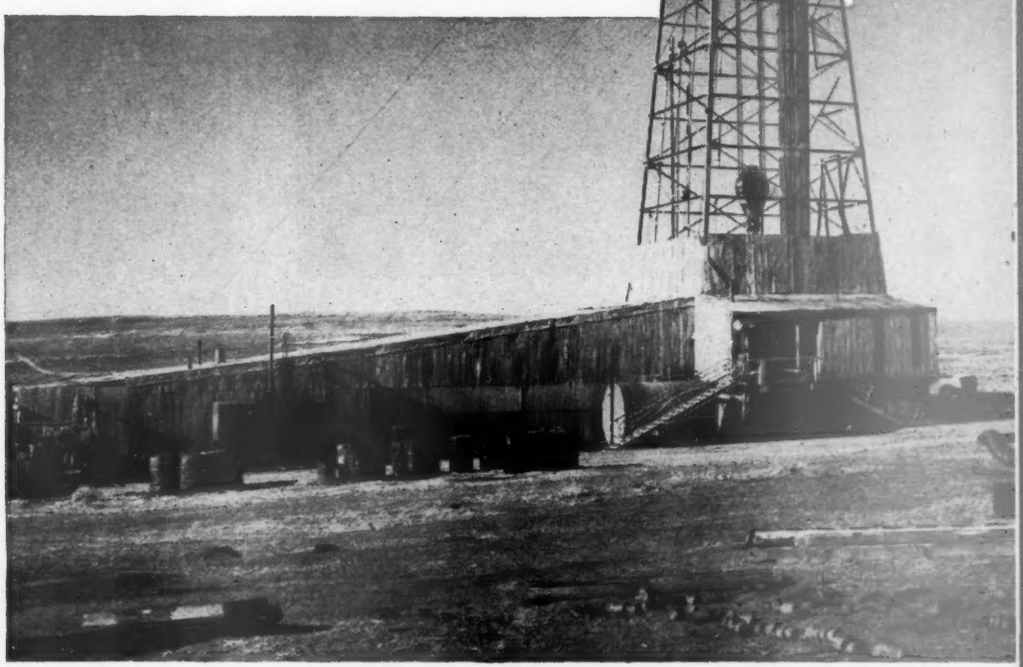

LOCATED 31 miles west of Casper, Wyoming, in West Poison Spider Unit No. 3, this well was recently completed to produce from the Morrison Sandstone at a depth of 16,102 feet. (T.D. before plug back, 16,603 feet).

All of the more than 16,000 feet of 7" O.D. casing and the 2" and 2½" tubing in this record breaking well was NATIONAL Seamless.

It is no mere happenstance that you'll find NATIONAL Seamless Tubular Products in the forefront of every advance made in drilling, refining and transportation of petroleum. For more than fifty years, whenever new records were in the making, NATIONAL Seamless drill pipe, casing and tubing has been called upon with confidence. Its established reputation for the utmost dependability has made it the logical choice whenever the job was unusual or tougher than ordinary.

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- Seamless Drill Pipe and Casing
- Electrogalvanized Couplings
- "Rotary Rolled" seamless pipe
- Round thread Drill Pipe, Casing & Tubing
- Internal Upset Casing
- Deoxidized Bessemer Steel Seamless Casing
- First drill collars from seamless pipe
- Warm Worked Casing
- Deep Well Casing
- Buttress Thread Casing

WALLS WITHOUT WELDS

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

UNITED STATES STEEL

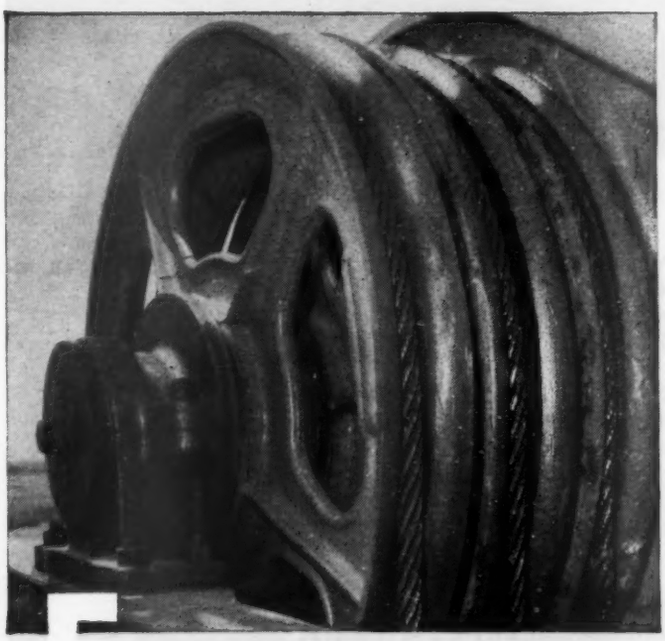
Six ways to put more life

1

Don't use a line that's too small. It will wear out faster and cost you more per ton mile than the correct size of line. For deep drilling the 1¼" line is common and some drillers are trying 1⅜" lines with good success.

2

Use a line that's long enough for a few cut backs. Wear and fatigue are usually most severe at certain points. The removal of short lengths distributes these destructive forces over different sections of the line and results in much longer service.



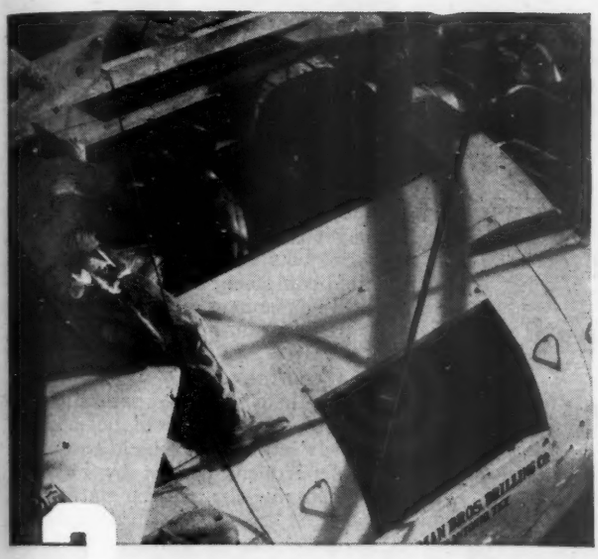
5

Avoid badly worn sheaves. Smooth sheaves with full-sized grooves increase wire line life.

6

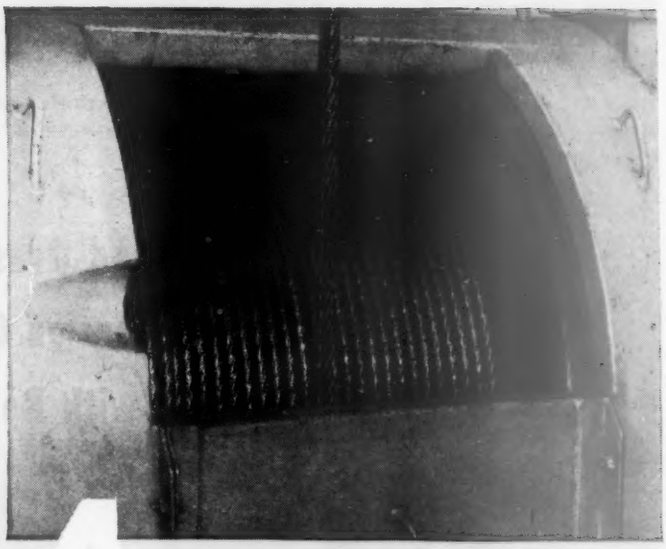
Don't speed. It causes excessive vibration and danger of cross winding on drums.

into your wire lines



3

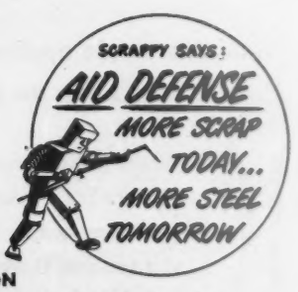
Reverse the ends. Wear from sheaves and fatigue from vibration can be distributed more evenly by turning the line end for end.



4

Don't neglect lubrication. We shouldn't have to remind an oil man about lack of lubrication, but this is still a common cause of wire line failure. A 6 x 19 wire line has 115 moving parts—each sliding on the others. If you think of a wire line as a machine—like your automobile—you will lubricate it more often. American TIGER BRAND Lines come from the factory thoroughly lubricated with "Tiger-Lube," the finest wire line lubricant available. But even this dissipates in time and the wire line needs to be relubricated before it is too late.

In spite of all these "pitfalls" a reasonable amount of care and maintenance will assure long service life from your TIGER BRAND Lines. They are made of the toughest steels and are properly built to do the job for which they are designed and intended.



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Trade News

U. S. Steel Changes Corporate Structure

In the program of simplifying the corporate structure of United States Steel, United States Steel Company has been merged into United States Steel Corporation. United States Steel Corporation, the surviving corporation, will succeed to all of the properties and rights of United States Steel Company and assume all of the responsibilities and obligations of such company.

All business formerly conducted by United States Steel Company will be conducted in the name of United States Steel Corporation. After that date, purchase agreements entered into will be in the name of United States Steel Corporation and payments made and other action taken on and after that date under purchase agreements previously entered into will be made in the name of United States Steel Corporation.

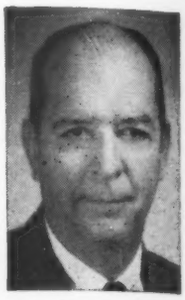
Emsco Changes Name

Emsco announces a change in its corporate name from Emsco Derrick and Equipment Company to Emsco Manufacturing Company. "This change in name is being made," states Bill Powell, Emsco's president, "in keeping with the wide variety of products manufactured by the company. Derricks today represent a very small part of our business and we feel that it is important to have a name descriptive of our operation."

Beaumont Iron Reports Sales Program Reorganized

Consolidation of the sales offices of Beaumont Iron Works Company with a general sales office in the Dunlavy Building, Houston, Texas, has been announced by A. T. Lawrance, general manager of the Beaumont company. T. L. (Doc) Fontaine will be manager of oil field equipment sales and A. Y. Gunter will be manager of southwest sales of heat transfer and processing equipment, Atlas valves and the automatic tank shut-off control.

A. Y. Gunter



T. L. Fontaine

Under the new sales organization, oilfield equipment sales will be made by the newly established oilfield equipment sales department headed by Fontaine. T. L. Fontaine, Jr., will be stationed in the general sales offices at Houston. C. A. Warthen is in charge of Odessa plant; C. P. Gillespie, Houma plant.

North Dakota Shop Opened

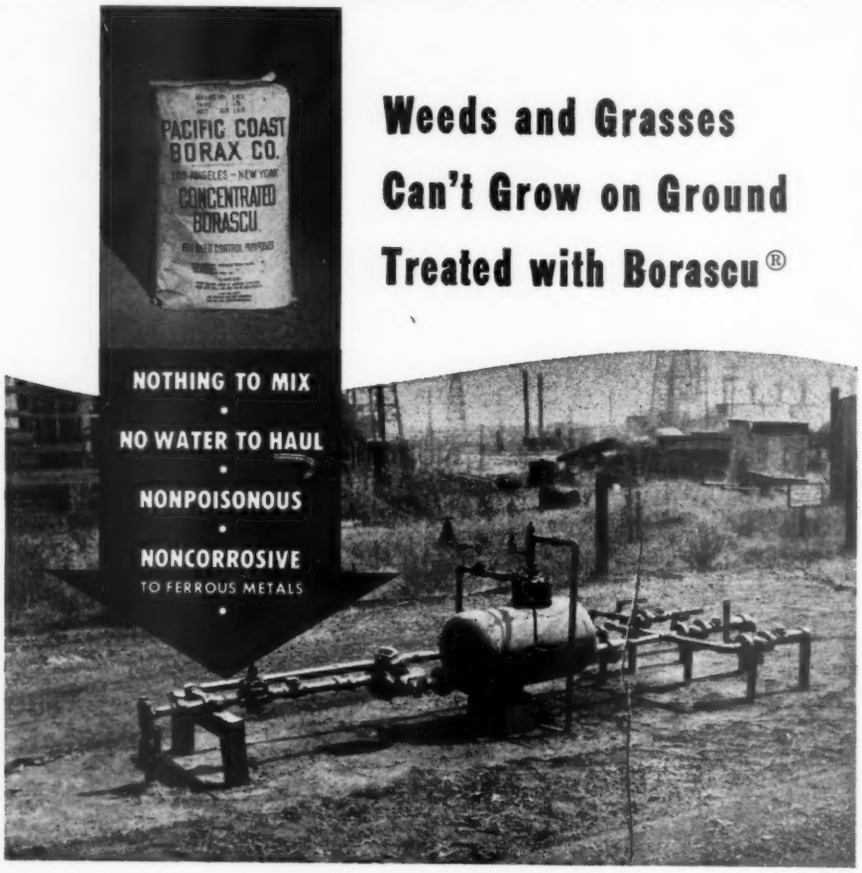
The A-1 Bit and Tool Company has built and opened an oil field machine shop in Tioga, North Dakota, to take care of the repair needs of the several oil fields in that area. The new shop is equipped with all modern machine tools for the repairing of drawworks, threading of drill pipe and drill collars, etc. Joe Castles, former district manager for the company at Beaumont, Texas, is now Rocky Mountain division manager, with headquarters at Tioga. Harry Dull, formerly with Tex-La Tool Company of Beaumont, is shop superintendent of the new installation.

Service Pin Awards

Ten employees representing 130 years' service were recently honored by The Continental Supply Company in Dallas, Texas, it has been announced by F. M. Mayer, president of the organization. They were honored guests at the annual service pin award dinner held recently in the Adolphus Hotel.

Those who received pins were: W. F. Kemp and R. E. F. Smith, both of whom have been with Continental for 35 years; D. N. Hursey with 25 years; and the following who have five years' service, Kenneth Pittman, C. V. Watson, Mrs. Allie Vee Everitt, Mrs. Ruth Gutgesell, Mrs. Janet Adams, Mrs. Dorothy Fahrlander and Mrs. Sylvia Rape.

Employees of the Dallas home office who have already received pins for five or more years' service made up the some 120 guests at the dinner. Mayer made the presentation of the pins.



Weeds and Grasses Can't Grow on Ground Treated with Borascu®

.....a single application of Borascu Weed Killer may keep an area cleared for 1 or 2 years!

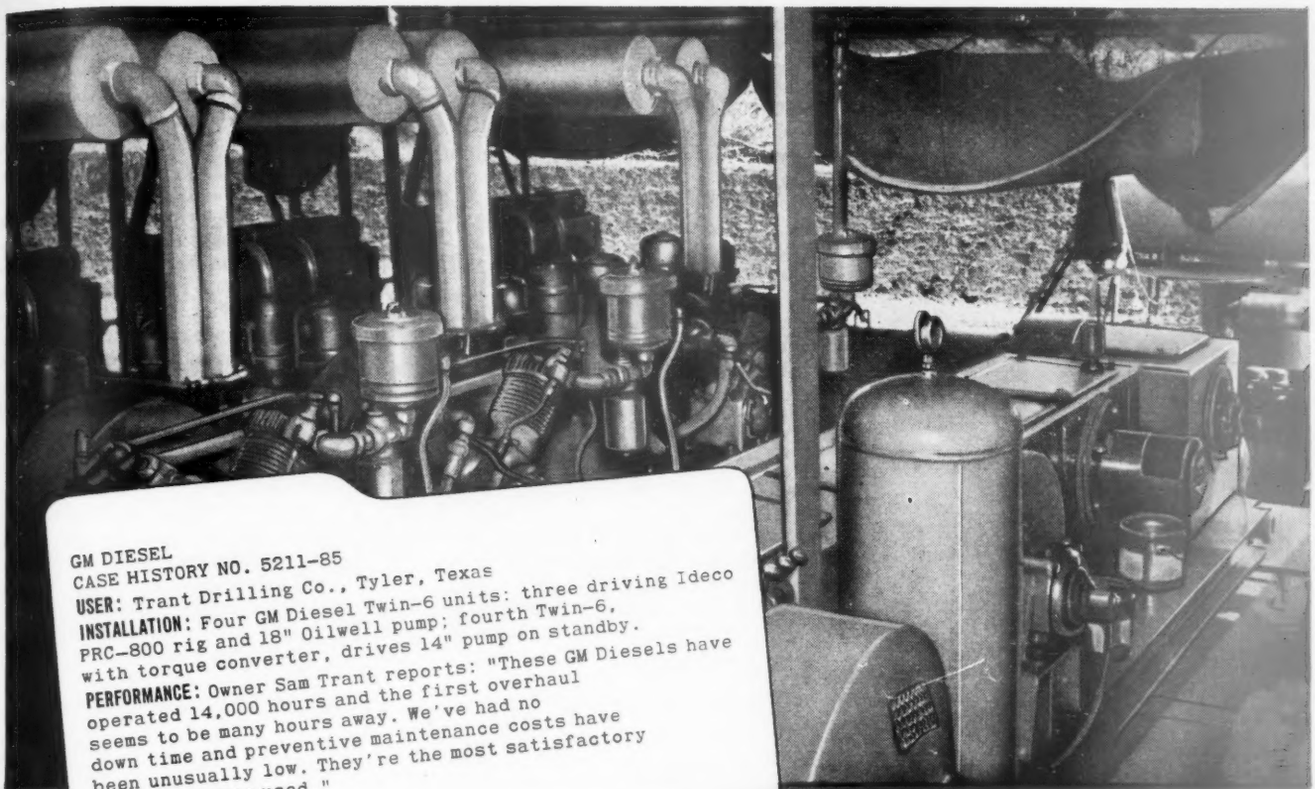
Where ground must be kept bare of all fire-hazardous weeds and grasses... that's the place for BORASCU! This weed killer gives long-lasting results because it goes into the soil, and remains there, where it can destroy plant life, *roots included!* Economy-minded production men like BORASCU; figure it saves up to 80% of former "grassing" costs... and it's safe, nonflammable, easy to use. Write for literature.

DISTRIBUTORS LOCATED THROUGHOUT OIL FIELDS OF U.S.A., CANADA, MEXICO, COLOMBIA, VENEZUELA.

PACIFIC COAST BORAX CO.

DIVISION OF BORAX CONSOLIDATED, LIMITED

630 SHATTO PLACE • LOS ANGELES 5, CALIFORNIA



GM DIESEL
CASE HISTORY NO. 5211-85
USER: Trant Drilling Co., Tyler, Texas
INSTALLATION: Four GM Diesel Twin-6 units: three driving Ideco PRC-800 rig and 18" Oilwell pump; fourth Twin-6, with torque converter, drives 14" pump on standby.
PERFORMANCE: Owner Sam Trant reports: "These GM Diesels have operated 14,000 hours and the first overhaul seems to be many hours away. We've had no down time and preventive maintenance costs have been unusually low. They're the most satisfactory engines I ever used."

WORKED 14,000 HOURS

with no down time

Preventive maintenance pays off, even in such quality products as GM Diesel engines. It has given Mr. Trant thousands of extra hours before overhaul, and no down time.

To help other General Motors Diesel owners operate their engines at lowest possible cost, Detroit Diesel has prepared a new Preventive Maintenance Log Book. It makes preventive maintenance so systematic that it is easier to do than forget. It lists checks to be made, jobs to be done each shift. At a glance, the driller knows whether all steps have been taken. It indicates what repairs may be needed so that servicing can be scheduled — virtually eliminating shutdowns. GM Diesel owners may obtain this Log Book from any GM Diesel distributor listed below.

DETROIT DIESEL ENGINE DIVISION
GENERAL MOTORS • DETROIT 28, MICHIGAN
SINGLE ENGINES ... 16 to 275 H.P. MULTIPLE UNITS ... Up to 840 H.P.

It pays to Standardize on

GM
GENERAL MOTORS
DIESEL POWER

Write for booklet, "A 50,000,000 Horsepower Insurance Policy" that tells you why.

Trade News

J&L Becomes Division

The Jones and Laughlin Supply Company, Tulsa, Oklahoma, a wholly owned subsidiary of Jones and Laughlin Steel

Rainey Elliott

J. L. Shakely

Corporation, has become a division of J&L. All assets of the J&L Supply Company will be transferred to the parent corporation. Canadina assets of the J&L Supply Company will be sold to the J&L Steel Sales Company, Ltd., a Canadian subsidiary, which will carry on the Canadian business previously conducted by the J&L Supply Company.

The newly named supply division will be headed by Rainey Elliott, Tulsa, who has been vice president and director of the supply company. He will become general manager of the newly formed supply division.

John L. Shakely, Tulsa, president of the supply company, is retiring from active service after 39 years with the supply company and its predecessor, Frick-Reid Supply Corporation. He will remain in a consulting capacity.

These additional personnel changes also became effective:

George L. Sutter, Tulsa, director of sales for the supply company since last August, will become assistant general manager.

Robert J. Woods, Jr., Tulsa, assistant director of sales of the supply company, will become director of sales.

Paul R. Warner, Tulsa, treasurer and credit manager of the supply company, will become assistant treasurer and credit manager.

Harold H. Wilson, Houston, Texas, a vice president of the supply company, will become director, Gulf Coast operations.

H. Lee Wilkins, Calgary, Alberta, Canada, manager of Canadian operations of the supply company, will become manager, Jones and Laughlin Steel Sales Company, Ltd., supply division, with offices in Calgary.

Elliott joined the present organization in 1935 as a local store manager in Electra, Texas.

L. A. Miller Is Agent

L. A. Miller Company, Administration Building, Bowman field, Louisville, Kentucky, has been appointed by The Davison Chemical Corporation as manufacturer's agent for the sale of Syloid 308 and associated products in the areas around Louisville and Evansville, Indiana. Syloid 308 is a flatting agent for lacquers, to subdue the gloss and give a hand-rubbed finish effect to furniture.

Ensign Continues Expansion

To further meet the increased demands for Ensign carburetion equipment for natural gas and propane, Ensign Carburetor Company announces the purchase of a 5-acre site east of Los Angeles for a new factory and laboratory.

Emphasis has always been placed on engineering research and laboratory facilities at Ensign. Newly developed laboratory equipment for complete studies of LP-Gas behavior and utilization, particularly with respect to internal combustion engine use, has been completed at Ensign's present plant. The entire facilities of this modern laboratory will be relocated at the new sight.

Collins Is General Manager

Thomas A. Collins, executive vice president of Glass Fibers Inc., has been appointed general manager of the company. In his new capacity he will coordinate production, sales, advertising, and public relations acitvities. Collins is a graduate of the University of Illinois.

Eggelhof Engineers Move

Eggelhof Engineers, Inc. has recently moved into new, enlarged offices at 4331 Belmont in Dallas, Texas. The move is part of a continuing expansion program at Eggelhof. Other branches of Eggelhof are in Tulsa, Oklahoma; Shreveport and New Orleans, Louisiana; Houston, Corpus Christi, San Antonio, Lubbock, Fort Worth, Texas, and Little Rock, Arkansas.

X A.P.I. COUPLINGS FOR OIL FIELD USE

EVERY SIZE AND TYPE FROM *ONE* SOURCE

LINE PIPE COUPLINGS A.P.I.
1/8" to 12"—Seamless and Special Processed—Black or Galvanized

PLAIN TUBING COUPLINGS A.P.I.
1" to 3"—Seamless

EXTERNAL UPSET TUBING COUPLINGS A.P.I.
3/4" to 3 1/2"—Seamless

CASING COUPLINGS A.P.I.
4 1/2" to 13 3/8"—Long or Short

HYDRAULIC COUPLINGS
1/8" to 3"—Seamless

REAMED AND DRIFTED A.I.S.I.
3/4" to 12"—Seamless or Spl. Processed

DRIVE PIPE COUPLINGS
3/8" to 12"—Seamless or Spl. Processed

Consult Our Nearest Quick Service Sales Office:

Albany, N. Y.—Albert L. Becker, 434 Clinton Ave.
Baltimore—Ted Barto, 2301 N. Charles St.
Buffalo—W. E. Spencer & Assoc's, 241 S. Elmwood Ave.
Chicago—Harry A. Jay, 122 So. Michigan Ave.
Denver—Earl H. Jones & Co., 1863 Wazee St.
Detroit—Thomas L. Osberger, 19451 Livernois Ave.
Erie, Pa.—R. J. Maggi, Box 711
Falmouth, Mass.—Wm. F. Bennett, 53 Minot St.
Ferguson, Mo.—Wm. H. Heckenberg, 635 No. Florissant Road
Houston—Henry H. Paris, Distributor, Inc., Box 932
Los Angeles—James A. Riordan Co., 1400 Santa Fe Ave.
Minneapolis—Lin J. Krause, 200 Lumber Exchange
Norbeth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Murry Eskin, Industrial Office Bldg.
New York—Henry Stein, 50 Cliff St.
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., Mutual Bldg.
San Francisco—Earl H. Jones & Co., 1150 Folsom St.
Seattle—Earl H. Jones & Co., 819 Thomas St.

FACTORY PHONE: WOODSDALE 3296

WHEELING MACHINE PRODUCTS COMPANY
ELM GROVE STATION — WHEELING, W. VA.

Only LE ROI A-288 OFFERS YOU A 10,000-HOUR WARRANTY!

Past performance makes this amazing 14-month warranty possible

No ordinary pumping engine — only Le Roi A-288's unusual record of uninterrupted pumping service in actual installations — gives you this unprecedented warranty. Over 14 months (10,000 hours) of dependable pumping! Within that time you spend not one cent for repair parts — A-288 performance assures it — Le Roi guarantees it!

While other engines are ready for the replacement tag at 10,000 hours, the Le Roi A-288 is just nicely broken in — ready for thousands more hours of dependable service. One typical installation shows more than 47,000 hours with practically no downtime and still going strong — proof of sturdy stamina.

Just look at a few reasons for the A-288's dependability . . .

- Patented, closed "vaporizing-condensing" cooling system requires almost no make-up water — keeps temperatures uniformly high and prevents sludging even in sour gas areas.
- The A-288 is the only pumping engine to be recommended by one major user for continuous service *unattended for up to two weeks at a time.*
- Short, solid, properly counterbalanced crankshaft is 5" in diameter, has extreme overlap between crankpin and main bearing journals for added strength.
- No shut-down is required for inspection or adding oil.
- Heavily constructed and internally ribbed integral crankcase and base is rigid to resist distortion due to temperature differences or faulty mounting.

Send the coupon today for up-to-the-minute details on the new A-288 10,000 hour warranty. And take a look at the list of Le Roi distributors, an important cog in Le Roi's 3-way partnership, that means more efficient service to you.

LE ROI COMPANY

MILWAUKEE 14, WISCONSIN

***Plants:* Milwaukee • Cleveland • Greenwich, Ohio**

***Oil-field Headquarters:* Tulsa, Oklahoma**

Oilfield Sales-Service Network

Oklahoma
Le Roi Company Branch — Tulsa
Carson Machine & Supply Co. — Oklahoma City

East & South Texas, Gulf Coast
Southern Engine and Pump Company — Houston, Kilgore, Edinburg, Dallas, San Antonio, Corpus Christi, Texas, and Lafayette, Houma, Louisiana.

North & West Texas, New Mexico
General Machine & Supply Co. — Odessa, Synder, Texas.
Nortex Engine & Equipment Co.—Wichita Falls, Texas.

Kansas
Carson Machine and Supply Co.—Great Bend

Illinois — Western Kentucky
Western Machinery & Engine Company — Centralia, Illinois and St. Louis, Missouri.

Michigan
Hofer Engine Service — Reed City

Rocky Mountain Area
Gehring Equipment Co. — Casper, Wyoming, Rangeley, Col.

Mississippi, Arkansas and Northern Louisiana
Ingersoll Corporation — Shreveport, Louisiana, Jackson, Mississippi, El Dorado, Arkansas

West Coast
Le Roi-Rix Machinery Co. — Los Angeles, Long Beach and Bakersfield, Calif.

Appalachian Area
P. C. McKenzie Co., Pittsburgh, Bradford.

Canada
Lucey Export Ltd. — Calgary, Edmonton, Alberta.

Le Roi Company
302 N. Cincinnati Ave., Tulsa 3, Oklahoma

Gentlemen:
I don't believe it! Show me how you can afford to offer a warranty on this pumping engine and make it good for 10,000 hours — the equivalent of over 14 months operation — running 24 hours a day. Send the proof to:

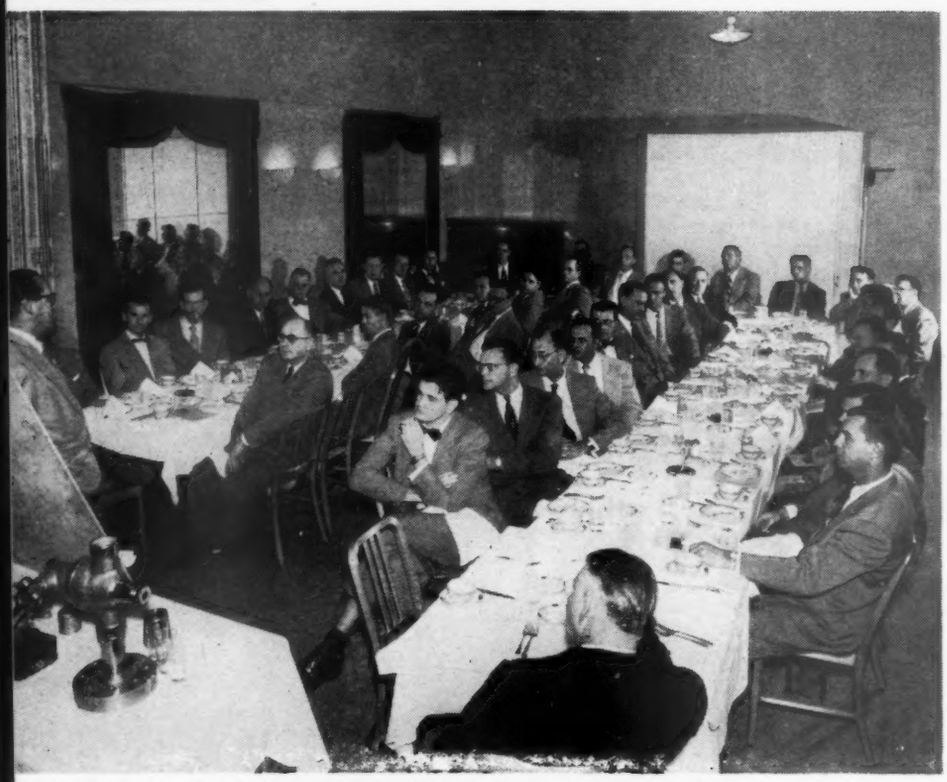
Name.....Title.....

Company.....

Address.....

City.....Zone.....State.....

P-117



Cameron Iron Works of Houston was host to approximately 50 petroleum process plant constructors and engineers at a recent meeting in Houston, Texas. A number of the industry's leading construction engineering firms were represented: Brown and Root, The Lummus Company, Delta Engineering Company, Grebe and Doremus, O. L. Olsen, Hudson Engineering Company, and Fluor Corporation. According to Jack Harris, manager of the industrial valve division this was the forty-second meeting sponsored by his company to acquaint employees with features of the Cameron non-lubricated lift plug valve.

in DRILLING— ALL Radiator Cooled Engines — GAS or DIESEL in Stationary or Mobile Service have no problem with rust and scale when using:

SAND-BANUM SPECIAL

Pure Concentrated Colloidal Tablets

LIKE NOTHING ELSE

SAND-BANUM SPECIAL safely, surely and easy removes old rust and scale; prevents new from forming.

So Easy

Just drop 1 Tablet in radiator to each 6 gals of water once a month. No mechanical installation, replacement or labor.

GUARANTEED

absolutely harmless to personnel and equipment. Fully effective regardless of water or operating conditions. ORDER TODAY through your supply house or direct.

AMERICAN SAND-BANUM Co.
Established 1926
9 Rockefeller Plaza
New York 20, N.Y.
SAND BANUM

Minerals Separation Buys Attapulgus Clay Firm

Sale of the fullers earth business of the former Attapulgus Clay Company to Minerals Separation North American Corporation has been announced, the combined business operating under the new name of Attapulgus Minerals and Chemicals Corporation, This move brings together two business activities long identified with research, process development, and licensing, mining, and manufacture in the field of industrial minerals.

Officers of the new corporation include: David E. Lilienthal, chairman of the board; L. R. Streander, president; R. H. Hubbell, Jr., vice president in charge of sales; Dr. E. W. Greene, vice president in charge of minerals separation division, and W. E. Sawyer, Jr., secretary and treasurer.

New Distributors Named

Morris, Wheeler and Company have been appointed distributors for seamless pressure tubing in iron pipe sizes manufactured by U . S. Steel's National Tube division. Edward S. Siddall, manager, the boiler tube division, said the company will stock a range of sizes — $\frac{1}{8}$-in. to $1\frac{1}{2}$-in. inclusive — in standard and extra heavy, made to specification A-83. The new line is in addition to complete stocks of national seamless and Republic Electrunite boiler and condenser tubes regularly carried in stock, Siddall reported.

Ethyl Sets Up New Aeronautical Section

Dan M. Guy, director of technical services for Ethyl Corporation, announces the creation of a new aeronautical section with Ferd Gillig named as its head. The new section has been established as a technical service activity for the aviation and petroleum industries in order to provide more effective services. Gillig joined Ethyl in 1932 and until recently he was manager of aviation research operations.

Lane-Wells Adds Stations

Lane-Wells Company has opened three new stations in the United States and Canada. The Mid-Continent division has established the Glendive, Montana, truck station with Charles L. Naus as station superintendent. Naus, previously stationed at Williston, North Dakota, has been employed by Lane-Wells since 1940. He has been associated with the petroleum industry since 1936 when he was with Cities Service Oil Company. The Gulf Coast division has opened a new truck station at Winters, Texas. W. D. Copper, a Lane-Wells employee since 1946, is operator-in-charge. Copper was previously stationed at Wichita Falls, Texas.

Lane-Wells also announced the establishment of a truck station at Virden, Manitoba. Joseph H. Donovan, formerly at Edmonton, is operator-in-charge.

Semet-Solvay Division Enters Petrochemical Field

Semet-Solvay Division, Allied Chemical and Dye Corporation, 40 Rector Street, New York, New York, announces it is now producing on a small plant scale at Buffalo, New York, a new material derived from ethylene, called Alcowax. A full-scale petrochemical plant is under construction at the same location for the production of this material and will be in operation some time in 1953. It is reported that unlike most other polymers of this type the present grade of Alcowax has wax-like hardness and a melting point of approximately 100 C. It is further stated that the material has the properties of being hard, of white translucent color and is tasteless, non-toxic, and substantially odorless.

Contracts Awarded Whitmor

Three large housing contracts totaling more than $1,000,000 have been awarded to Whitmor Homebuilders, Inc. Altogether, 74 homes and five office buildings will be constructed in a five-state area including Texas, Mississippi, Kentucky, Tennessee, and Alabama. Largest single contract, according to Burl Johnson, vice president, was awarded by the Texas Eastern Gas Transmission Corporation for 31 homes which will be built along a pipe line running from Kosciusko, Mississippi, to Owingsville, Kentucky.

The other two contracts include an 18-home project for the Rancho Pipe Line Company and a 25-home contract and five office buildings for the Mextex Pipe Line Company.

Thirtieth Anniversary

TULSA

MAY 14-23
1953

EXPLORATION
DRILLING
PRODUCTION
PIPE LINE
REFINING
SCIENTIFIC

OUTSIDE SPACE NOW AVAILABLE

Contact IPE immediately if you want to take advantage of additional outside space immediately adjacent to main buildings. Any size space with utility services now available. Act immediately.

Wm. B. Way, General Manager
Box 5246, Donaldson Station
Tulsa, Oklahoma

F. M. Mayer

B. L. Hindman

V. C. Moore

G. R. Pike

R. F. Gregg

N. D. Lane

Continental Supply Revamps Organization

Due to expanding operations, The Continental Supply Company has put in effect a new organization plan, Frederick M. Mayer, president, has announced. Four of the Mid-Continent areas that have been operated in the past as districts have become divisions. Headquarters for these divisions are Tulsa, Fort Worth, Houston, and Shreveport, with R. A. Brewer, R. L. Collier, Raleigh Hortenstine, Jr., and E. N. Wood as division managers, respectively. Each region formerly supervised by an assistant district manager will now be directed by a district manager.

As a part of the new plan, some reassignment and further subdivision of existing areas have been made so as to afford closer supervision to the expanding operation. B. L. Hindman has been made assistant division manager of the Arkansas - Mississippi - Louisiana - East Texas division with L. C. Judy and J. R. Chapman becoming district managers.

A new subdivision, the southern half of Western Oklahoma, is under the supervision of Van C. Moore as new district manager of the area. H. J. McMann, Oklahoma City, and R. O. Hambric, Wichita, are now district managers of their respective regions.

W. T. Hays has been named district manager for the Permian Basin sector of West Texas. Glen R. Pike is district manager of the new subdivision composed of New Mexico and a portion of West Texas. T. H. Fraser is district manager for North Texas.

W. G. Sharp is district manager of the Louisiana Gulf Coast region. R. F. Gregg has been designated as district manager of the new subdivision of South Central Texas. E. E. Tyer will continue to maintain his sales contacts in the Houston office, and in addition will take over the position of manager of tubular sales, Gulf Coast division. Noble D. Lane is district manager of the Southwest Texas area, succeeding W. E. Young, who has been transferred by request to San Antonio as manager of that office.

The Rocky Mountain and Tri-State areas have not been affected by the reorganization and will continue to operate as districts, these being under the supervision of W. D. Craig, Casper, and C. H. Fischer, Evansville, as district managers, respectively.

The entire operation will continue to be under the direct supervision of Frank I. Brinegar, executive vice president, Dallas. Noble A. Endicott, vice president, continues in his same capacity.

J. D. Spalding, works manager.

L. H. Hill, manager oil field products.

Just Equipment Is Agent

Appointment of Just Equipment and Supply Company Ltd., Montreal, Quebec, Canada, as industrial and marine distributor for Nordberg Type 4FS diesel engines in the Province of Quebec is announced by Nordberg Manufacturing Company. Just Equipment and Supply is situated at 173 Colborne Street in Montreal. President and general manager of the Montreal company is T. F. Just and G. P. Morrison, secretary-treasurer. A. J. Williscroft is assistant manager and directly in charge of engine sales and supervisor of service. H. R. Kemp and S. Guttman are assistant sales manager and parts manager respectively. In addition to this the firm has six salesmen in the field. The shop, managed by Superintendent C. H. Leahy, has 15 mechanics.

New Headquarters Acquired

The change of the headquarters of Maloney-Crawford of Canada Ltd. from Edmonton to 810 Lancaster Building, Calgary is announced by S. P. Wallace, president, Maloney-Crawford Tank and Manufacturing Company of Tulsa. George H. Cheatam is vice president in charge of the Canadian subsidiary. It is also announced that stocks, sales, and service representation is now maintained at Birden, Manitoba.

Torrance Plant Notes Fortieth Anniversary

December marked the fortieth anniversary of the founding of the Torrance, California, plant of the National Supply Company, as well as the city of Torrance. Among the original employees still at the plant are Walter E. Moll, Edward Timbs, and Fred B. George.

Works manager for the plant is John D. Spalding, who became active head of the plant upon retirement of D. S. Faulkner. Lloyd H. Hill has been named manager of the oil field products division. A program was begun recently to modernize the company's six plants in the Torrance area.

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1953

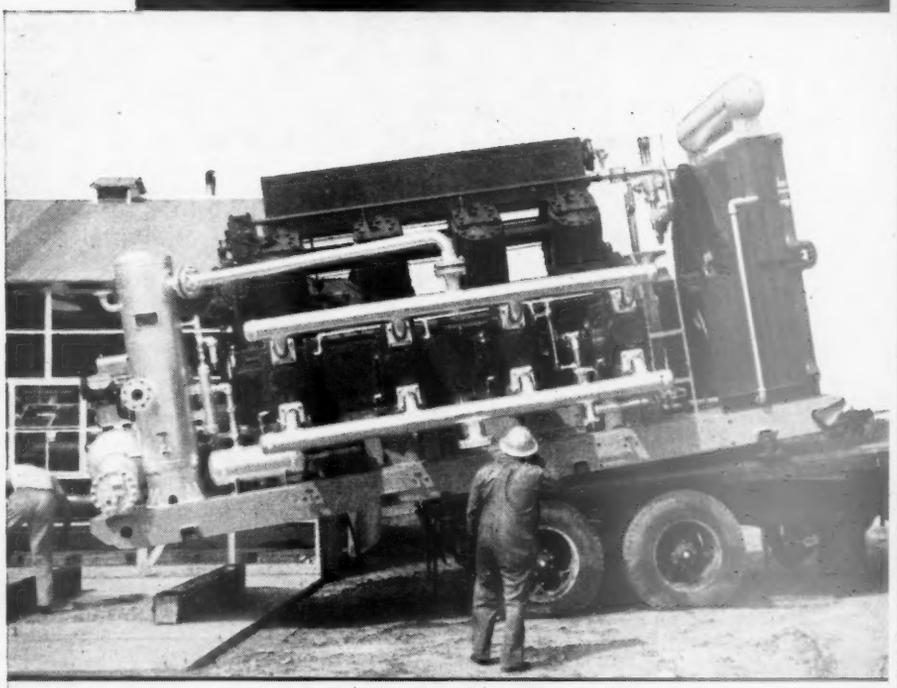
XUM

XUM

BEAIRD Ingersoll-Rand Packaged Compressor Plant

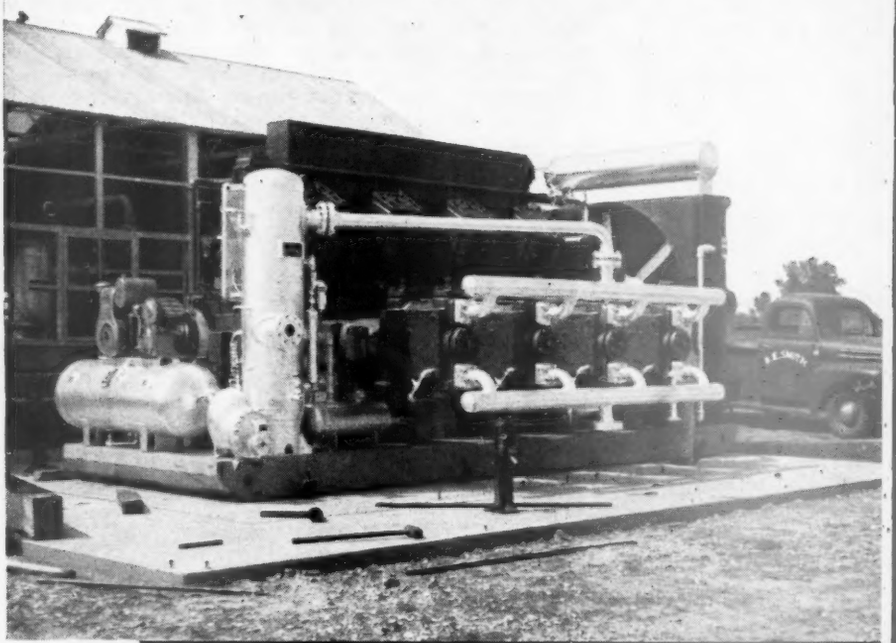
Straight from the Factory

This 440-horsepower packaged compressor plant was completely assembled at the factory — loaded onto a truck — and is shown as it arrived on location. There is no more assembling to be done — no more last minute fit-ups — no delay for missing parts — because the plant is complete to its last piece of piping. And look at the rigid steel base — how it permits the entire plant to be skidded off the road truck.



Ready to Connect up

The entire plant has been jacked down off of the blocks onto a simple concrete slab foundation. Now it's ready to be levelled, grouted, and connected to suction and discharge lines. A light shelter like the one covering the packaged plants in the background is all that is necessary to protect it from the weather — and there's no need to build a house for a regular attendant — the plant doesn't require one.



Let us tell you about our completely assembled, easy to install packaged compressor plants.

THE J. B. BEAIRD COMPANY, INC.
SHREVEPORT, LOUISIANA

MACHINING
FABRICATING
STEEL WAREHOUSE

SINCE 1918 BEAIRD SHREVEPORT
LOWEST COST PER HORSEPOWER, INSTALLED

PRESSURE BULK STORAGE

ANHYDROUS AMMONIA EQUIPMENT

CAST STEEL FITTINGS

PACKAGED COMPRESSOR PLANTS

LP-GAS SYSTEMS

XUM

THIS IS "Oil Country" CONTROL

Built the way oil men told us to build it

Cutler-Hammer 9589 oil well pumping controller with 3 coil overloads and time delay relay.

You know and we know that there are no operating conditions anywhere as tough and rough as oil country conditions. And that is why Cutler-Hammer Engineers went to the oil country when they designed their oil well pumping control, talking to operators, production men, maintenance crews, getting the story on the spot.

To beat the heat, C-H engineers made the case finish of sun reflecting aluminum, built in louvres at the top and bottom to drain off the heat at the top and bring in fresh air at the bottom. The contact structure is out in the open where heat radiates freely. You never see a C-H Controller with door propped open to keep it working.

To beat the dust, and dirt, and insects and rain, they not only louvred but bronze-screened and baffled the ventilator openings; they used the famous C-H dust safe Vertical Contacts that shed dust; they neoprene-gasketed the timer mechanism and provided an excess torque clock motor that keeps going even if dust accidentally gets in.

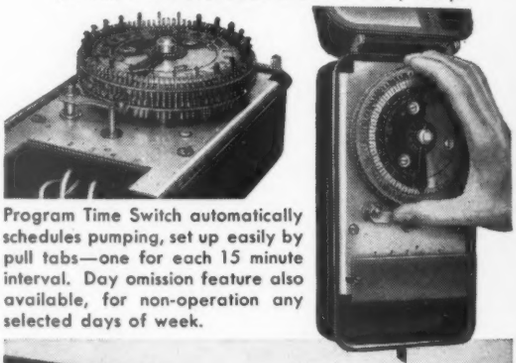
They provided 2 coil overload relays where conditions are normal, and 3 coil overload relays where single phasing is a common occurrence.

They provided undervoltage relays where manual restarting is desirable, and automatic time delay relays where automatic staggered restarting is wanted. The mounting arrangements are universal so you can easily change from one to another. Or you can short out the staggered starting for instantaneous automatic restarting.

You can change the on-off sequence simply by pulling out small, accessible tabs in 15 minute increments. You can have an automatic day omission feature if you want it.

Other features are unit lightning arresters that tell at a glance if one is blown—but *won't* blow up the works with it. There's a plastic coated wiring diagram with spare parts listing, that doesn't become smudged and unreadable from greasy handling.

These oil well pumping controllers are used everywhere, proved everywhere, preferred everywhere. Try one and *see why*. CUTLER-HAMMER, Inc., 1459 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate*: Canadian Cutler-Hammer, Ltd., Toronto.



Program Time Switch automatically schedules pumping, set up easily by pull tabs—one for each 15 minute interval. Day omission feature also available, for non-operation any selected days of week.

MEMBER AMERICAN PETROLEUM INSTITUTE

TRADE PERSONALS

Glenn E. Seidel has been elected a vice president of Minneapolis-Honeywell Regulator Company in charge of engineering in the company's Minneapolis plants. Seidel, a member of Honeywell's engineering organization since 1943, has been director of the company's expanding ordnance division for the past year and a half. Before that he served for a number of years as assistant to W. J. McGoldrick who, as part of his duties as vice president, has been handling the engineering activities that Seidel will take over.

G. E. Seidel

A. W. Francis, Jr.

J. L. Maher

A. W. Francis, Jr., formerly vice president and assistant chief engineer, has been appointed vice president in charge of sales for National Tank Company. Francis is a graduate of the University of Oklahoma. He served as a trainee engineer at Phillips Petroleum and was with Smith Separator Corporation until he joined National Tank in 1937.

J. Louis Maher has been appointed assistant chief engineer of National Tank Company to succeed Francis. Maher is a chemical engineering graduate from the University of Oklahoma and was with Phillips Petroleum Company from 1934 to 1940 working in gasoline plant operation, design, and reservoir evaluation. He joined National Tank Company in 1946.

Kemp S. Lewis has been appointed manager, mineral and chemical sales, by the Baroid Sales Division, National Lead Company, of Houston, Texas. A chemical engineer and a graduate of Rice Institute, Lewis joined Baroid as a service engineer in 1939. He served as district superintendent in the well logging department in 1941 until entering the Navy in 1942.

K. S. Lewis

F. W. Budde has been named secretary-treasurer and **Kenneth N. Mills** chief engineer of the Walter O'Bannon Company of Tulsa, Oklahoma. Budde was formerly assistant to the vice president and treasurer of Tellepsen Construction Company, and has been with Jarecki International, H. K. Porter, and others.

Mills was formerly machinery products manager of the Dresser Equipment Company. Prior to that he was with Emsco Derrick and Equipment, Texasteel Manufacturing Company, and others.

J. V. Spalding has been appointed division sales manager of the newly created Gulf Coast division of Bethlehem Steel Company. Spalding will be responsible for city sales in Houston, Texas, and also all stores sales and activities along the Gulf Coast from McAllen, Texas to Laurel, Mississippi. Included in this territory are three districts, eleven stores, and three sales offices. Spalding has 13 years' experience in the Bethlehem organization, having begun in the Tulsa office as a sales engineer in 1939.

J. V. Spalding

Assisting Spalding in Houston will be **W. J. Brady** as resident sales manager in charge of sales and all other activities of the Houston sales office. Brady is being transferred from Corpus Christi, where for the past three and one-half years he has been district manager of the Southwest Texas district.

Replacing Brady in Corpus Christi will be **T. C. Graham,** who will assume the duties of district manager, Southwest Texas district. Graham has had both plant and sales experience during his eleven and one-half years with Bethelhem and was formerly city salesman in Oklahoma City.

Guy Brown, Jr., has been named division machinery sales representative with headquarters in Houston. Brown came to Bethlehem Supply in 1940, having completed the Bethlehem Steel Company sales training course.

Guy J. Coffey has been elected to the presidency of Chicago Pneumatic Tool Company. At a meeting of the board of directors of Chicago Pneumatic Tool Company Coffey, vice president, was elected president to succeed the late W. L. Lewis, who died on June 28, 1952. H. A. Jackson, chairman of the board, has been acting president since that date and will continue as chairman and chief executive officer.

Thomas P. Harris and James F. Huvane were elected vice presidents; and Thomas F. Noonan was elected assistant comptroller of the company.

John V. Boardman has been named works manager, Claymont plant of The Colorado Fuel and Iron Corporation. Boardman attended the University of Michigan and Carnegie Institute of Technology. In 1946 Boardman joined the Worth Steel Company, serving in the capacity of assistant plant manager and general superintendent. Since the merger of Worth Steel with Colorado Fuel and Iron, he has served as assistant works manager.

J. V. Boardman

Fordyce Coburn

Fordyce Coburn has been named district manager in charge of operations for the E. & G. Brooke, Claymont and Buffalo plants of The Colorado Fuel and Iron Corporation. Coburn is a graduate of Massachusetts Institute of Technology. He served as vice president of the E. & G. Brooke Company and the Richard Ore Company from 1944 to 1952, prior to their merger with The Colorado Fuel and Iron Corporation. Coburn will continue to serve as general plant manager of the E & G Brooks plant and as vice president of Richard Ore.

Earl N. McArthur, Jr., has been promoted to district service supervisor in the Victoria, Texas area for Magnet Cove Barium Corporation. McArthur's headquarters will be in Victoria. Previous to his appointment he was a field service engineer in the Victoria area. He was employed by Magcobar in 1949.

Earl McArthur, Jr.

David Fulton has been recalled to the Lummus Company's main office in New York City. Prior to recall, Fulton was for a number of years manager of Lummus' French affiliate, Societe Francaise des Techniques Lummus, in Paris. He returns to take up his newly appointed position of assistant to the president.

Fred B. Getten has been appointed manager of the Dallas, Texas, branch of Pioneer Rubber Mills. Getten, a graduate of Case Institute of Technology, has been active in the industrial rubber field for the last 18 years. He has specialized in product development research, engineering sales, and similar technical work.

F. B. Getten

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Trade Personals

Charles E. Glennon has been appointed sales engineer for the Platecoil division of the Kold-Hold Manufacturing Company. Glennon comes to Kold-Hold from six years' experience as chief of the industrial division and production engineer for the Chicago Chemical Procurement District of the United States Army. Glennon's professional career started with postgraduate work in metallurgy, engineering, and journalism. Following this he served six years at the Gary Works of Carnegie Illinois Steel Corporation.

John K. Dustman has been appointed manager of export sales in the New York office of The Youngstown Sheet and Tube Company. He joined The Youngstown Sheet and Tube in 1917 as a tally clerk in tube shipping. In 1939 he was moved to New York office as a salesman in the export department.

F. H. Webster has been appointed manager of Hyatt's western division sales office in Chicago, Illinois, as announced by Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey. He succeeds **C. L. Newby,** who has retired after 34 years of service with Hyatt in several sales capacities. Webster, prior to this appointment, was assistant manager of Hyatt's western sales division in Chicago.

F. E. (Ed) Siever has been named sales manager in the Permian Basin for Petroleum Tool Company and the Smith Bit Distributing Company, both Odessa, Texas, organizations. Siever has been division manager for TOTCO in West Texas and New Mexico since 1947 and had worked for TOTCO since April 1940, with the exception of two years during World War II. He attended the University of Tulsa and Oklahoma City University.

F. E. Siever

Robert Edwin Kirn, vice president and general sales manager of the C. Lee Cook Manufacturing Company, died on November 11 in Louisville. Born in Louisville, his first business association was with the American Elevator and Machine Company. In 1919 Kirn went to work for C. Lee Cook as a sales engineer and was sent to Oklahoma to survey the oil field territory. He was then sent to New York to establish a branch sales office for the company and to serve as its New York manager. Subsequently, he was promoted to general sales manager of the company and in 1930 became its vice president.

R. E. Kirn

R. J. Amberg, who has been senior sales representative for Johns-Manville Celite Division at Detroit, is appointed Cleveland district sales manager; **S. S. Childs,** formerly with the company's finance department, becomes comptroller of the Celite division; **Carl Dietz,** Cleveland district sales manager, is appointed New York district sales manager; **P. A. Martinson,** who has been senior sales representative at Minneapolis, is transferred to New York as product manager for fillers; and **W. J. Petersen,** formerly comptroller of the Celite division, is appointed production engineer with headquarters in New York.

Ed T. Landgraff, manager of Chiksan Export Company in the Newark branch office, left recently on a four-month trip through Latin America. His itinerary includes visits to Mexico, Panama, Colombia, Venezuela, Trindad, Brazil, Argentina, Chile, Bolivia, Peru, and Ecuador. He will work closely with Chiksan representatives and customers in these countries. In addition, Landgraff will investigate possible changes in marketing procedures due to the rapid growth of the Latin American market.

American Iron and Machine Works board of directors re-elected for the coming year are: J. A. Gray, chairman; V. L. Thomas, secretary-treasurer; E. E. Rubac, executive vice president and assistant general manager, and Cecil N. Cook, vice president and general counsel. A. J. Farfel, not shown, was named assistant secretary and a board member.

W. M. Burge has just been named manager, chemical sales, in the New York district for Oronite Chemical Company. Burge, who was transferred to New York from San Francisco, formerly handled special product sales for northern California and the Pacific Northwest. He has been with Standard of California for 30 years and with Oronite since its inception in 1943.

W. M. Burge

W. W. Leonard has been appointed assistant manager of tubular sales for The Colorado Fuel and Iron Corporation. Leonard's appointment is in preparation for the marketing and servicing of products from C.F.&I.'s new seamless pipe mill scheduled to open in the fall of 1953. Leonard is a Texas College of Mines and Metallurgy graduate engineer.

J. H. Walters has been named Houston district sales manager of the Rockwell Manufacturing Company. Walters will be responsible for the coordination of all meter and valve division sales in the Houston district, which covers sections of Texas and Louisiana. Walters became affiliated with Rockwell as a sales engineer in 1945 and prior to his recent appointment served as Houston gas sales supervisor.

J. H. Walters

Warren E. Scoville, Jr., has just been appointed assistant manager of the development department of United States Rubber Company's plant in Passiac, New Jersey. He will be responsible for further development of the 33,000 mechanical rubber and plastic products now made in the Passaic factory, and the development of new rubber and plastic products. Scoville has been in the company's development department since graduating from Stevens Institute in 1934. Lawrence Cranston is development manager at the Passaic plant.

Ross Mauldin has been named sales engineer for Tuboscope Company in south Louisiana and Mississippi. He has had 12 years' experience in oil field servicing. Tuboscope provides specialized oil field services for the inspection of new and used drill pipe, tubing, and casing, and miscellaneous inspection services for various drilling equipment plus tubing caliper surveys.

Ross Mauldin

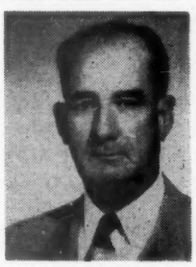
Frank Ford, Jr., has been promoted to district supervisor of the Houma, Louisiana, district of Magnet Cove Barium Corporation. Ford has been in the Houma district since he was employed by Magcobar in 1948. He replaced **R. E. Hinchliffe**, who was transferred to the Lake Charles district as supervisor.

Roy W. Gronauer has been appointed assistant general sales manager of OPW Corporation, Cincinnati, manufacturers of valves, fittings, and assemblies for handling hazardous liquids. Gronauer joined OPW in 1949 as sales engineer. In his new position he will assist the director of sales and will coordinate sales promotion and advertising.

R. W. Gronauer

G. F. DeCoursin has been appointed to the position of general sales manager of The Four Wheel Drive Auto Company. DeCoursin came to FWD in 1936. In 1945 he was made manager of the standards department. At the University of Wisconsin and the University of Iowa, which he attended on leave of absence, he concentrated on business and sales management. He was promoted to the sales department early in 1949 and in 1950 became field sales manager in charge of all the sales activities of FWD dealers and salesmen.

Henry M. Stanley, salesman for McEvoy Company, has been transferred to Corpus Christi, Texas. Stanley has been with McEvoy Company since 1944, in the capacity of a salesman, with headquarters in Alice, Texas, and operations covering southwest Texas, including Corpus Christi, San Antonio, and south. His operations will continue in the same area.


H. M. Stanley

James M. Crawford, general manager of the motor and generator division of General Electric Company, has been named vice president of the company. Other general managers named vice presidents include: **Francis E. Fairman**, general manager of the transformer and allied products division, Pittsfield, Massachusetts; **Cramer W. LaPierre**, general manager of the aircraft gas turbine division, Evendale, Ohio; **Clarence H. Linder**, general manager of the major appliance division, Louisville, Kentucky; **Harold A. MacKinnon**, general manager of the component products division, Fort Wayne, Indiana; **Charles K. Rieger**, general manager of the small appliance division, Bridgeport, Connecticut; **Glenn B. Warren**, general manager of the turbine division, Schenectady; and **William C. Wichman**, general manager of the industrial power components division, Plainville, Connecticut.

E. D. (Chuck) Bishop has joined C.R.C. Engineering Company in an executive position with the title of director of purchases. In addition to his duties as director of purchases, Bishop will be directly in charge of the administrative division of C. R. C. Engineering Company. Bishop will direct purchases of approximately $150,000,000 for the company's contract with the U. S. Pipe Line Company for design engineering and supervision of construction on the products pipe line which will extend from Gulf Coast refineries to East Coast markets.

Chuck Bishop

Kenneth S. Ross, well-known export manager for Baash-Ross Tool Company, recently returned from an extensive business trip which included most of the major oil territories in Latin America. Principal areas visited included East and West Venezuela, Colombia, Central America, and Mexico.

K. S. Ross

Stanley Kimball has been named assistant resident manager for Kaiser Engineers Division of Henry J. Kaiser Company on its construction project at the Hanford plutonium works. Kimball has moved to Richland from Oakland, California, Kaiser Engineers' headquarters, where he has been chief construction engineer responsible for joint-venture heavy construction activities. Kimball joined Kaiser in 1934, moving to Oakland in 1938.

Hugh H. Glen has submitted his resignation as chairman of the board and director of Emsco Derrick and Equipment Company. Glen was elected chairman of the board of Emsco last May to be effective July 1, after having served as president of the company since 1939.

H. H. Glen

Glenn Huckaby has been named sales representative in the Southern Louisiana, Mississippi, and in Alabama areas for Baash-Ross Tool Company. Huckaby took his engineering courses at Magnolia A&M, and for the past 6 years has been prominent in Louisiana oil field supply activities.

G. Huckaby

Trade Personals

Artis M. Duty has been named sales engineer in the Houston, Texas, branch office of The Airetool Manufacturing Company. Duty has a degree in mechanical engineering obtained from Texas A. & M. He will call on refineries, pipe line operators, and drilling contractors, to acquaint them with the Airetool line of tube cleaning and tube expanding equipment and oil refinery specialties.

A. M. Duty

Murray C. Moffatt has been appointed manager of the Fort Worth division of Magnet Cove Barium Corporation, George Moore, Magcobar general sales and service manager, has announced. Moffatt replaces **Bill Ray,** who will assume full-time duties as assistant to the president, Willard M. Johnson. Before his new appointment Moffatt was sales manager of the Fort Worth division. His office is at 910 Continental Life Building, Fort Worth. Before joining Magcobar in April 1952 Moffatt was associated with the Gulf Oil Corporation in Fort Worth as a petroleum engineer. He received his degree in petroleum engineering from the University of Texas in 1941.

J. B. Vaughan has been named general sales manager for Welex Jet Services, Inc., replacing A. M. Birnie, who left the company to move to California. Vaughan comes to Welex from the Great Lakes Corporation, where he was the assistant general sales manager. He also has been associated with Halliburton Oil Well Cementing Company and Fred M. Manning, Inc.

J. B. Vaughan

C. H. Bouvy has been promoted to the position of chief design engineer at Le Roi Company. **Henry Osterkamp** has been promoted to the position of field research and development engineer for the construction and mining equipment sales department of Le Roi Company. Bouvy, who was an engine designer with the Cadillac Division of General Motors Corporation before joining Le Roi in 1944, will be in charge of both engine and compressor design for Le Roi.

Thomas E. Burns has been appointed direct factory representative for Macwhyte Company with headquarters in Houston, Texas. He will represent the wire rope manufacturer in their Houston territory including an area in Louisiana. He has been employed by Macwhyte for the last 12 years.

William B. Kempton has been named sales manager of the hardware products department of the Wickwire Spencer Steel Division of The Colorado Fuel and Iron Corporation. Kempton is a graduate of the Massachusetts Institute of Technology. Prior to his joining The Colorado Fuel and Iron Corporation as a salesman in the New England district sales office, he was associated with the United States Steel Corporation.

G. D. Fisher

W. B. Kempton

Gerald D. Fisher was named assistant sales manager of the department. In 1945 Fisher joined Colorado Fuel and Iron and since that time he has been responsible for the promotion of hardware sales in the Chicago district.

W. J. (Bill) Williams has been named works manager for Baash-Ross Tool Company, in which position he will be responsible for coordinating production and manufacturing operations throughout the 17 major plants and service shops. His normal field of operations will cover all of the Baash-Ross plants throughout the United States, with his headquarters at the Los Angeles plant.

W. J. Williams

W. C. Buchanan has been re-elected chairman of the board of directors of Le Roi Company. Also re-elected were: **E. O. Boshell, G. V. Meyers, James Carlson, T. O. Liebscher, P. W. Ells,** and **R. R. Morgan.**

Following officers were re-elected: **T. O. Liebscher,** president; **P. W. Ells,** vice president; **R. R. Morgan,** vice president in charge of Cleveland division; **K. E. Gifford,** Greenwich, Ohio, vice president in charge of Le Roi-Centaur Division; **G. J. Hamm,** Milwaukee, secretary-treasurer; **J. R. Gavigan,** Waukesha, assistant treasurer, and **C. W. Decker,** assistant secretary.

D. J. (Don) Hall has returned to the McCullough Tool Company in the capacity of regional sales manager for the Western and Rocky Mountain divisions. Hall first joined McCullough in 1942 as a salesman in the Bakersfield area. In 1945 he became sales manager of the Bakersfield district. In 1950 he joined the Great Lakes Corporation as regional manager of the California, Rocky Mountain, and Canadian divisions.

D. J. Hall

L. T. Prince, technical service representative of Oakite Products, Inc. receives the D. C. Ball award for distinguished service from John A. Carter, left, president of Oakite. Award is given annually to a member of firm adjudged to have contributed the most outstanding service to industry during the year. Receiving honorable mention was L. W. Cunningham, member of the company's technical field service organization.

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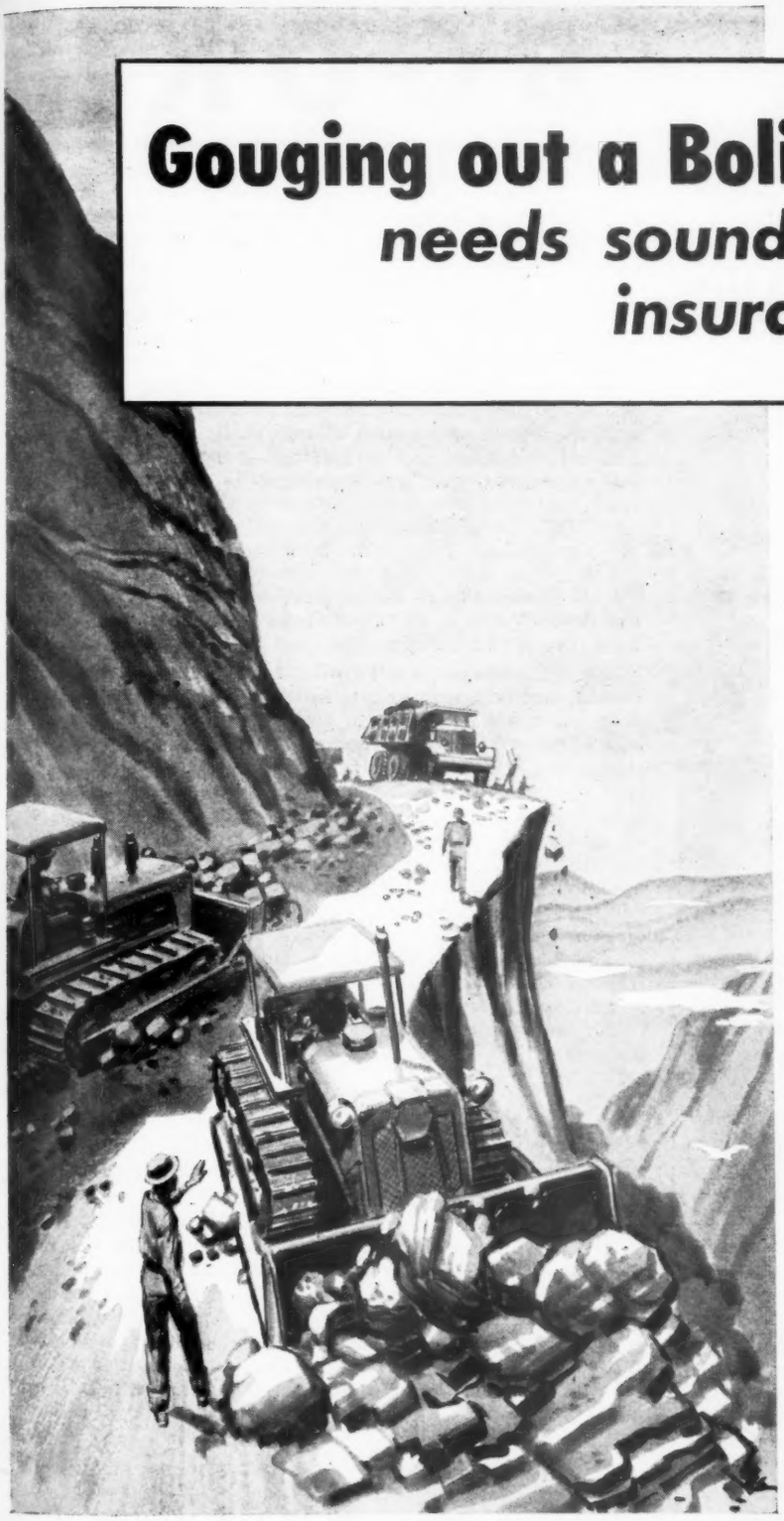

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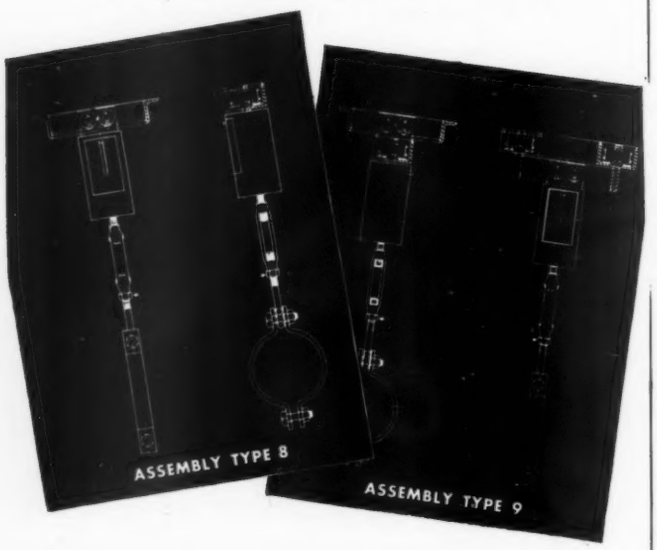

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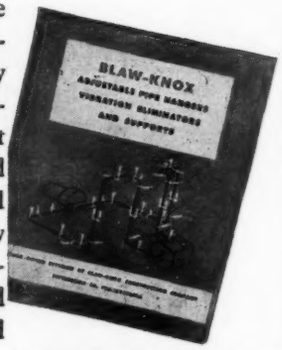

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BOOKS

▸ **Welding with Stainless Steel Electrodes,** *published by The Lincoln Electric Company, 22801 St. Clair Avenue, Cleveland 17, Ohio. Price, $0.25. Pages, 32.*

This booklet contains reprint of material from the "Procedure Handbook of Arc Welding Design and Practice," and was published so as to make this information more generally available. It covers welding of chromium-nickel steels, with and without molybdenum, as well as the welding of straight chromium steels, together with complete procedures. Contains analysis of most of the types of such steels. Also gives A.W.S.-A.S.T.M. classifications of corrosion-resisting chromium and chromium-nickel steel welding electrodes (Specification A298-48T).

☆ ☆ ☆

▸ **Field Geology,** *by Frederic H. Lahee. Published by McGraw-Hill Book Company, 330 West 42nd Street, New York 36, New York. Price, $8.50. Pages, 855.*

New Fifth Edition of this standard field manual is completely revised, and brings up to date existing material, including new developments in such areas as geophysics, well-logging, and air photography. The general policy is followed of explaining the similarities and differences between phenomena which in certain respects resemble one another but which may be of radically diverse origins. New features include: Rewritten chapter on air photography; revised phraseology; additional data on lineation, calcareous reefs (bioherms), paleogeology and paleography; time relations of stratigraphic units; gamma ray and neutron logging, caliper logging, lithofacies, and panel or fence diagrams; short section on underground surveying; addition of four new appendixes on natural tangents, curvatures and refraction corrections, length of degrees of the parallel, and lengths of degrees of the meridian; and new articles on electronic methods of location and on air-borne magnetometer surveying.

☆ ☆ ☆

▸ **Principles of Invertebrate Paleontology,** *by Robert S. Shrock and William H. Twenhofel. Published by McGraw-Hill, Inc., New York, January 1953. Price, $12. Pages, 816.*

This is a revised and enlarged edition of the previous publication, "Invertebrate Paleontology." The text and diagrams have been completely and thoroughly revised and considerable new data have been added. A good reference index is included in the book.

The authors, experts in the field of paleontology, have gone at great length to incorporate all essential detail. It is a book, indeed a tool, that the paleontologist cannot afford to be without.

☆ ☆ ☆

▸ **Automation, The Advent of the Automatic Factory,** *by John Diebold. Published by D. Van Nostrand, Inc., 250 Fourth Avenue, New York 3, N. Y. Price, $3. Pages, 175.*

This book is primarily an essay on the business problems of automation and indicates the manner in which technological developments can be useful to the business man. The possibilities, limitations, and social and economic consequences of the revolutionary new machines of the electronic age that correct their own mistakes and carry on complex repetitive tasks with complete skill and precision are described. Businessmen, labor leaders, government leaders and workers of all kinds will be interested in the drastic changes that will be brought about in the adoption of automation. The problems of readjustment and rethinking that will be necessary are touched upon and many case stories of office and factory are given. The first presentation of its kind, the book should raise provocative questions in the minds of anyone who reads the analysis.

Books

Economics of Natural Gas in Texas, *by John R. Stockton, R. C. Henshaw, and R. W. Graves. Pages, 316. Bureau of Business Research, University of Texas, Austin, 1952. Price, $5.*

The most outstanding feature of this work at first glance is the great number of tables of statistical information included in it; 87 tables, 38 charts, and 19 figures in its 316 pages. The authors have gone at the business of assembling all types of data, pertinent to the subject, with lavish hand, leaning on the Bureau of the Census, various oil and business journals and reviews, American Petroleum Institute, and other sources of first-hand statistical material. The subjects of these tables range from annual natural gas consumption of the United States to the cost of heating a typical home, and the amount and ratio of fuel costs to the market price of finished products.

Much of the "running" market and production data will be of historical value only to the study of gas economics. For example, internal-combustion engine fuel potential figures are given from 1950 published figures. Liquefied petroleum gas is discussed at some length in terms of the turn of the half-century, and statements are referred to which indicate that cars may be run on LPG in future, whereas great numbers of automotive vehicles use LPG as fuel now. Significant are the chapters on political control and regulation of the gas industry, and that on measures of gas conservation with which the Oil Compact Commission and the Texas Railroad Commission are very active. In a so-fast-moving industry some of the tabulated data appear to be somewhat ancient, but doubtless serve a useful purpose as historical background.

☆ ☆ ☆

Seismic Prospecting for Oil, *by C. Hewitt Dix. Published by Harper and Brothers, New York, November 1952. Price, $7.50. Pages, 414.*

The subject is treated on a practical basis. The field man can find many answers to his problems in this book. It is also a useful text for the college student as the gamut of seismology is discussed.

One great asset is that the author has affixed mathematical annotations to the diagrams and the formulae are presented in a simple manner.

☆ ☆ ☆

Petroleum Facts and Figures, Tenth Edition, *published by American Petroleum Institute, New York City. Price $1.50. Pages, 250.*

This edition of *Petroleum Facts and Figures* brings up to date the statistical record of the American petroleum industry in the postwar period. It supplements data over the longer term which were published in the ninth edition. The book contains 250 pages including 334 tables, comprising a reference volume helpful to all. Coverage in this edition has been extended to exploration, marketing, and world demand. Where, however, data are available in the ninth edition and there is no subsequent information, these tabulations have not been included.

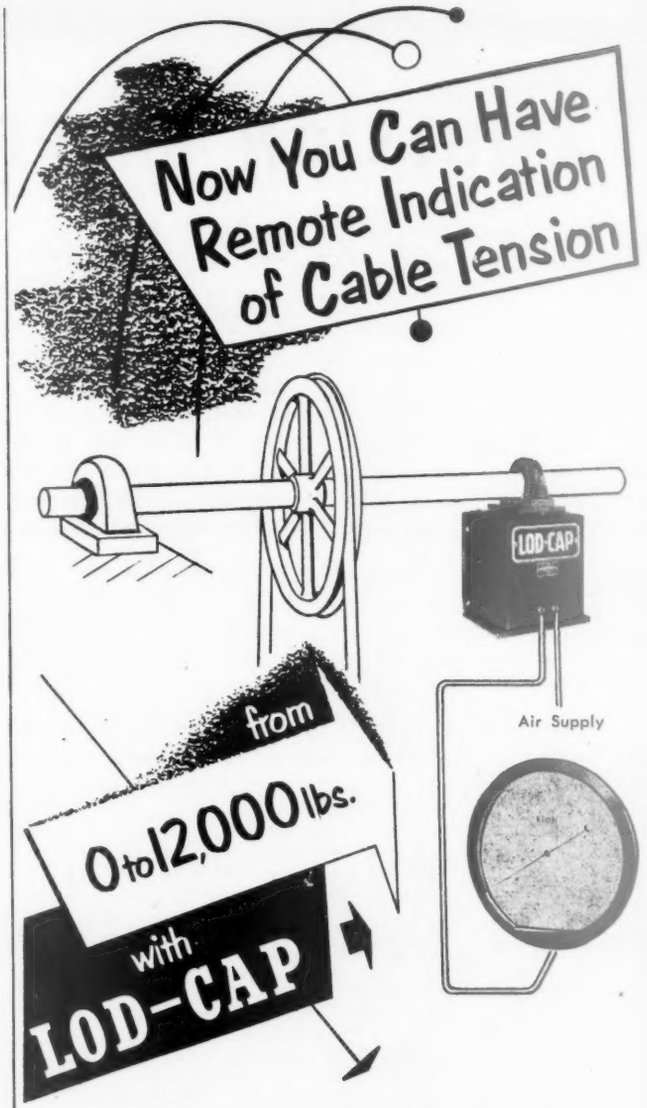
☆ ☆ ☆

Heat Transfer Phenomena, *by Dr. R. C. L. Bosworth. Published by John Wiley & Sons, New York; Pages, 211. Price, $6.*

Written by an outstanding authority from Australia, this monograph is credited by its publishers and the technical fraternity as being a review of recent developments in the transfer of heat, in applied physics and physical chemistry. The author states that "this presentation***makes the significance of, and limitations on, the value of analogies between heat flow, fluid friction, chemical diffusion, and the electric current, and attributes some of the special features associated with heat flow to the ubiquity of the 'carrier' for molecular energy or heat."

Briefly, the work takes up the thermal conductivity of gases, radiation, and convection, forced convection and simultaneous transport of heat and mass, thermodynamical similarity, and other phases of the subject. A considerable number of simple charts are employed to illustrate discussion in the text, and condensed mathematical treatment is utilized widely throughout the volume.

The book will be of much use to the student and the scientist in this field who wishes a condensed, authoritative summary of current and recent past developments.



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GIVEN below is as unbiased a field test of emulsion-breaker performance as it is believed possible to secure. All production factors (except the quantities of chemicals used, and first-test circulation and recycling) were kept uniform throughout. Each entry indicates one day's production; the tests following one another chronologically on normal production schedules.

These tests were made to determine the most efficient and economical emulsion-breaker treatment *for the producer.* Neither Visco nor any competitive manufacturer or service organization supervised the tests; and no changes in the respective emulsion-breaker formulas or dosages were made during the trial periods after initially-recommended dosages by field service representatives.

Dollar-wise, without consideration of time and labor savings, Visco cost was *$0.99 per 100 barrels less . . . over 6 times the amount of dry oil was produced per gallon of Visco . . . and no circulating or recycling was necessary with Visco.*

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1	165.35	31.2	0.2	1 gallon	Tank Bottom Recycled
3	30.31			"	
4	331.22			"	
5	179.14			"	
6	176.96	31.3	0.3	"	Tank Bottom Recycled
7	181.92			"	
9	31.68	32.7	0.2	"	Tank Bottom Recycled
10		32.7	0.2	"	Tank Bottom Recycled
12	174.89			"	
13	77.19			"	
14	53.97			"	
18	11.71	33.7	0.1	"	Tank Bottom Recycled
19	379.60			"	
20	191.62			"	
22	86.71			"	
25	5.52	32.2	0.2	"	Tank Bottom Recycled
26	157.31			"	
28	187.72			"	
29	242.73			"	
32	77.83	31.6	0.3	"	Tank Bottom Recycled
33	76.25			"	
TOTAL	2819.63			21 gallons	

134.27 bbls. dry oil /gallon of chemical

SECOND TEST RUN WITH VISCO

TEST DAY	OIL PRODUCED, BARRELS	GRAVITY	% B. S. & W.	AVG. VISCO CHEMICAL INJECTED	REMARKS
34	273.70			0.692 qts.	
35	144.75			"	
36	89.58	31.8	0.2	"	
40	15.72	32.3	0.2	"	
41	38.77			"	
43	215.72			"	
44	132.33			"	
47	258.20			"	
48	136.43			"	
49	128.10			"	
50	66.12			"	NO RECYCLING OR CIRCULATION NECESSARY WITH VISCO TREATMENT
54	218.45	32.6	0.2	"	
55	186.05	31.3	0.2	"	
56	97.98			"	
57	212.19			"	
58	119.85			"	
59	4.13			"	
60	296.99	32.6	0.2	"	
61	194.81	32.4	0.2	"	
64	59.26			"	
65	299.09			"	
66	73.01	32.6	0.2	"	
70	110.74			"	
71	211.75			"	
72	126.78	31.7	0.3	"	
TOTAL	3710.50			4.325 gallons	

857.91 bbls. dry oil /gallon of Visco

Phone Visco for fast action on efficient, economical emulsion-breakers for your use . . . Visco welcomes comparative cost-speed-quality tests on any emulsions in any field. Call Houston, CAPITOL 7300, collect, now!

VISCO PRODUCTS COMPANY
INCORPORATED
City National Bank Building • Houston 2, Texas

Visco... CONSISTENTLY EFFICIENT DEHYDRATING AND DESALTING CHEMICALS

New Machinery and Supplies

Use reply card to procure promptly complete information and prices of products described here in brief.

Circle corresponding letter or letters on reply card

(A) TEL ANALYSES

Time required to determine the tetraethyl lead content of a single sample of gasoline has been cut from three hours to ten minutes by a new X-ray photometer method developed by Ethyl Corporation's gasoline testing division, it is announced. Even when analyzing samples efficiently in large batches and using the fastest chemical means, the average operator time per test is about 18 min and the new X-ray method is reported to reduce the time by as much as 45 per cent.

Circle letter (A) on reply card.

(B) PIPE THREADER

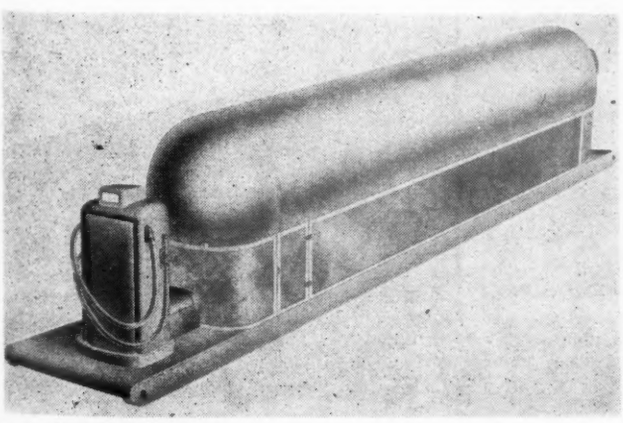
With a total weight of only 26 lb, the Port-A-Pony is a featherweight portable power pipe threader for threading pipe in the shop or in the field, recently developed by the Thread-Ezy Manufacturing Company. The Port-A-Pony utilizes the ring gear principle to turn dies at the most efficient cutting speed required to thread ¼-in. to 4-in. pipe on construction, maintenance, or installation job.

Circle letter (B) on reply card.

(C) FILLING STATION

A new completely packaged LP-gas filling station has been announced by the J. B. Bearid Company, Inc. Designed for servicing motor vehicles which use LP-gas as fuel, it includes a 999-gal pressure storage tank, metering dispenser, pump, and all necessary hose, piping, valves, and fittings. A formed screen of expanded metal encloses the supports. Fittings for filling the tank are enclosed in a steel protective hood.

Circle letter (C) on reply card.



LPG filling station developed by J. B. Beaird Company.

(D) GREASE APPLICATOR

A new method of applying lubricant to tool joints, drill collars, drill tubing, and casing has been developed by Jet-Lube, Inc., to avoid contamination and eliminate waste with complete coverage

of the threads and maximum speed and ease of application. The equipment, known as the Jet-Lube applicator, consists of a flexible head, swivel-mounted to a handle, and a trigger-operated control valve.

Circle letter (D) on reply card.

(E) GRAB HOOKS

A new type alloy steel grab hook is now being manufactured by the S. G. Taylor Chain Company. The unique design is said to provide additional strength to that which is inherent in alloy steel. Taylor Chain further announces that all Taylor made alloy steel boomer chains will be equipped with the new alloy steel grab hooks.

Circle letter (E) on reply card.

(F) BOILER LEVEL INDICATOR

A new 12-in. dial indicator, operating on the differential pressure principle, has been made by The Foxboro Company. It can be mounted on a panel or pipe standard, bringing the dial to convenient eye level and enabling the operator to be constantly informed of water level conditions.

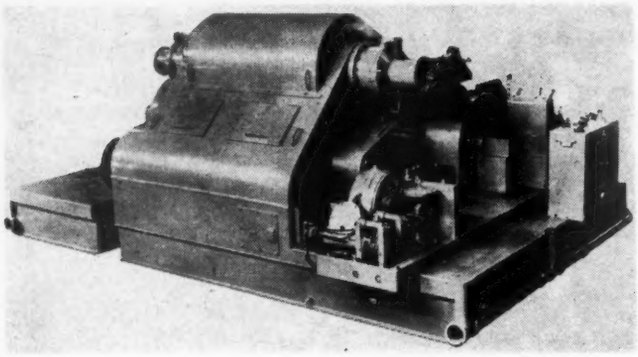
Circle letter (F) on reply card.

(G) HANDWHEEL

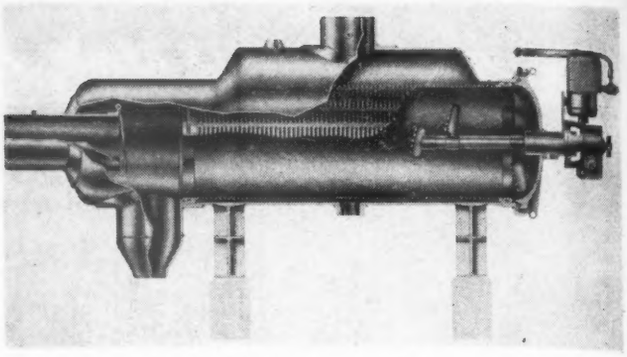
A new "Non-Slip" handwheel has been patented and is being introduced by The Lunkenheimer Company. Designed to turn easily and safely, the "Non-Slip" handwheel represents a scientific departure from the conventional type of valve wheel it replaces. The new handwheel features four finger-spaced lugs, all continuations of the strong spoke structure.

Circle letter (G) on reply card.

E. P. Lunken, vice president in charge of development, and H. A. Burdorf, vice president in charge of sales, examine new handwheel.



National Supply Company's new automatic feed-off control.



Jet-type self cleaning fluid pipe line strainer.

(H) FEED-OFF CONTROL

Development of an automatic feed-off control that will either (1) maintain a predetermined weight on a drilling bit, or (2) feed off the drilling string at a predetermined rate of bit penetration, has been announced by The National Supply Company. Known as the Ideal Micromatic drilling control, it can be supplied with new Ideal rigs of the larger sizes. It is also readily adaptable to existing rigs that have the conventional independently mounted Hydromatic or dynamatic auxiliary brakes.

Circle letter (H) on reply card.

(I) ELECTRIC MOTOR

A new totally-enclosed motor has just been developed by U. S. Electrical Motors Inc., designated as Type SS. It is designed for services where dampness, dust, fire hazards, and corrosive fumes are prevalent. Because of its construction, Type SS is self-cooling. This eliminates the use of an exterior fan and any unsightly, heat-dissipating fins. The smooth exterior greatly lends itself to wiping off or hosing down for motors used in dusty places.

Circle letter (I) on reply card.

(J) TUBING HEADS

National Supply Company has announced a new Type "E" tubing head, available in 2 body styles. The new heads are easily adaptable to any completion method, and may be used for flowing, rod pumping, gas, or hydraulic lift production. Rated at 200 psi working pressure, the new tubing heads are equipped with interchangeable tubing hangers.

Circle letter (J) on reply card.

(K) PIPE LINE STRAINER

Thornhill-Craver Company has developed a new jet-type self cleaning fluid pipe line strainer that greatly reduces the time and labor required for cleaning. In this new strainer, banks of rotating jets are arranged to clean the basket by hydraulic impact. One minute of this rotary scouring action, utilizing line product or water under high pressure, cleanses the basket and flushes the solids down the drain, the company reports. The entire cleaning operation takes only three to five minutes.

Circle letter (K) on reply card.

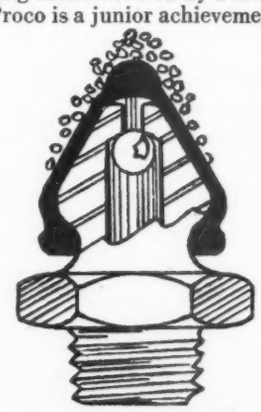
(L) DYNAMOMETER TESTS

Running dynamometer tests on rebuilt and overhauled diesel engines is rapidly becoming standard procedure in the service departments of many diesel engine distributors and dealers. According to A. F. Brecht, service manager of the Detroit Diesel Engine division of General Motors, a recent survey revealed that over 60 per cent of the division's distributors had, within the last 18 months, made this service available to their customers.

Circle letter (L) on reply card.

(M) PROTECTIVE CAPS

Protectips, a protective cap for alemite fittings on all types of engines, are now being manufactured by Proco Company. Proco is a junior achievement company sponsored by Mission Manufacturing Company of Houston. Three employees of Mission, Bass Hoyler, Don MacKenzie, and James Harrison, are consultants for the company. Members of Proco are high school students of Houston who are participating in the local Junior Achievement program.



Circle letter (M) on reply card.

Nicholson Expansion Steam Traps

SAVE $155 PER UNIT

for Large Processor

Because of their positive effectiveness in temperature control work, Nicholson expansion steam traps, at about $35 each, are being installed by a leading processor in place of temperature controls. These were costing them $110 to $200, with cost of trap added. Per installation, the saving is about $155.

This firm is finding an increasing number of applications on tanks, stills, heating radiators, etc., where Nicholson expansion steam traps are serving as both trap and temperature controller.

Because there is only one moving part, remarkably low costs are being shown. Easily installed, usually without supports. Lengths, 9" to 40". Pressure 0 to 250 lbs. No air binding.

CATALOG 751

For All Equipment Using Steam or Hot Water

Absorption Stills	Petrolatum Tanks
Agitators	Pipe Coils
Evaporators	Radiators
Gas Holders	Reboilers
Heat Exchangers	Steam Stills
Heavy Oil Tanks	Tar Tanks
Kettles	Wax Tanks

217 Oregon St., Wilkes-Barre, Pa.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

New Equipment

(N) PISTON ROD OILER

Oil Well Supply Division, United States Steel Corporation, has announced its new air-operated fluid piston rod oiler that fits all make slush pumps. Being air-operated, the oiler needs no V-belts, chains, gears, or shaft extensions to be installed. It can be controlled from the pump clutch valve . . . air connections are arranged so that the pump oiler automatically operates when the pump clutch is engaged and shuts down when the clutch is disengaged.

Circle letter (N) on reply card.

(O) LIGHT-WALL TUBING

Superior Tube Company has announced an increase in the size range of its seamless light-wall tubing from 1¼ in. OD maximum to 2 1/16 in. OD maximum. Heretofore, specialty tube mills have offered the larger diameter light-wall tubing only in welded grades. The increased size range of Superior's seamless grade is expected to increase the number of applications of light-wall tubing, particularly where pressures exceed the limits for welded tubing.

Circle letter (O) on reply card.

(P) REMOTE CONTROL UNIT

A new remote control unit for use with mobile radio communication systems was announced by the engineering products department of the RCA Victor Division, Radio Corporation of America. It is part of a line of new and improved RCA two-way radio equipment intended to meet all needs of public safety and industrial users. The new unit is designed for use with RCA's Carfone and "Fleetfone" systems, and can be incorporated into all other mobile systems operating in the 30-50 or 152-174 megacycle bands.

Circle letter (P) on reply card.

(Q) DIESEL ENGINES

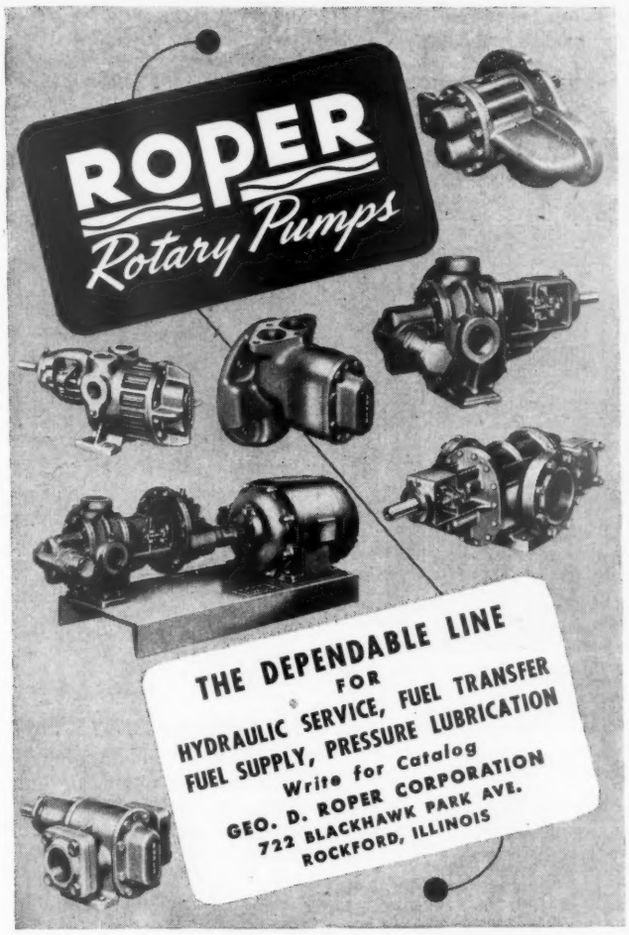
Design features of the new "Freedom Range" of Lister diesel engines have been announced by the engine division of The National Supply Company. National Supply recently became the sole distributor within the continental United States for Lister diesels. The engines are manufactured by R. A. Lister & Company, Ltd., Dursley, Gloucestershire, England. Engines, made in 1, 2, 3, 4, and 6 cylinders, in a range from 8 to 54 hp, were especially designed for operation at high speeds, and at tropic to Arctic temperatures, without impairing their standard of reliability. Each cylinder develops 9 hp at 1800 rpm, except the single-cylinder engine (FR 1) which develops 8 hp at 1500 rpm.

Circle letter (Q) on reply card.

(R) CONVEYOR

The industrial division of Continental Gin Company has placed on the market a new type unit sealed, prelubricated Timken bearing belt conveyor idler designed to operate for extended periods of time without relubrication. The Continental patented idler with its unit seal construction has been designated Type "UST."

Circle letter (R) on reply card.



Wherever Engine
POWER
is Needed...
Single cyl.
3 to 9 H.P.
2-cylinder
7 to 13 H.P.
V-type 4-cyl.
15 to 30 H.P.
WISCONSIN Air-Cooled ENGINES
Fit the Job and the Machine
Because Wisconsin Air-Cooled Engines are supplied in a complete power range, from 3 to 30 H.P., in 4-cycle single cylinder, 2- and 4-cylinder types, there is an ideal size to fit all types of machines and power applications within this range, without wasted power and with maximum power service benefits. Heavy-duty construction, combined with extremely compact design and light weight are added advantages—and dependable AIR-COOLING permits trouble-free service under all climatic conditions.
Specify Wisconsin Heavy-Duty Air-Cooled Engines for the utmost in power satisfaction. Write for descriptive data.
WISCONSIN MOTOR
Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines
WRITE TO HARLEY SALES CO.
619 S. MAIN STREET, TULSA, OKLAHOMA
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OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS.

FOR INDUSTRIAL APPLICATIONS REQUIRING POSITIVE CONTROL OF PRESSURE, TEMPERATURE, LIQUID LEVEL ETC.

SIMPLE TO ADJUST FOR THE SPECIFIED OPERATING RANGE

MERCOID CONTROLS ARE EQUIPPED WITH MERCURY SWITCHES, THEREBY INSURING GREATER SAFETY, BETTER PERFORMANCE AND LONGER CONTROL LIFE

Complete catalog sent upon request

THE MERCOID CORPORATION
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"Houston's Welcome to the World"

- Completely air-conditioned.
- Businessman's hotel in heart-of-Houston location.
- Four fine restaurants, excellent cuisine
- Famous Empire Room, nationally known orchestras, playing noon and night
- New 1,000-car garage
- Fabulous new PETROLEUM CLUB, entire top floor
- Room rates: from $4.50 single, from $6.50 double

B. F. ORR, *General Manager*

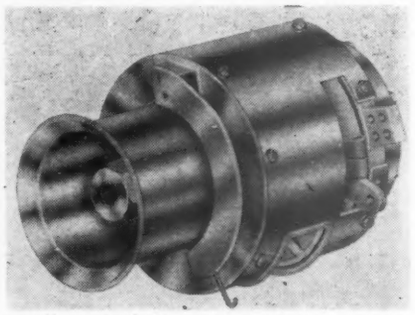
The Rice Hotel

HOUSTON • TEXAS

New Equipment

(S) CATHEADS

The American Iron and Machine Company has announced "Universal" friction makeup and breakout catheads designed for use on any size rig. Their



small, overall dimensions make them the most practical for small rig installation, while, at the same time, they have power sufficient to make up or break out any size connection. Because of small overall dimensions it is possible to move the jerkline closer to the shaft bearings. This eliminates the danger of kinking the shaft.

Circle letter (S) on reply card.

(T) PIPETTING SYSTEM

A new device developed by Central Scientific Company automatically dispenses controlled volumes of sterile liquids or chemical solutions at predetermined intervals with extreme accuracy. The Maisch automatic pipetting system consist of a motorized, stainless steel metering pump, an automatic recycling timer, and a pipette control unit. This completely automatic unit facilitates dispensing of serums, pharmaceuticals, reagents or other industrial solutions that may be required in laboratory or process control.

Circle letter (T) on reply card.

(U) PACKINGS

Greater resiliency, resulting in a better seal and longer life, has been imparted to the ordinary white braided asbestos Teflon impregnated packing by a new type construction that employs a braided or twisted core of Teflon impregnated glass fiber over which is braided several jackets of the best quality asbestos yarn thoroughly impregnated with Teflon. The improvement is most pronounced on high speed centrifugal acid pumps, where solid braided Teflon impregnated packing had a tendency to heat up due to its lack of resiliency.

Circle letter (U) on reply card.

(V) NEW DEODORANT

Phillips Scientific Laboratories has developed and manufactured a new chemical deodorant that removes odors in petroleum products, when added at the rate of 1:1000 to 1:2000; odors like sulfide, mercaptens, naphthenic acids, etc. This product is known as Mabros A No. 2. Another product, called Mabros S, is a solvent for gasoline to prevent lead fouling. It is added to gas at the rate of ½-1 fluid ounce per 16 gal. It gives fuel a boost also, since starting becomes easier especially in cold weather.

Circle letter (V) on reply card.

(W) CRANE CAPACITY

Additional crane capacity selection has been added to the Lorain line of cranes on rubber. A 30-ton lifting capacity machine is now available in both the Moto-Crane and self-propelled models. The new model designations are Lorain Moto-Crane Model MC-524 and Lorain self-propelled Model SP-524. The Moto-Crane consists of a 30-ton capacity turntable mounted on an automotive-type 3-axle carrier having 10 speeds forward and 2 reverse. The self-propelled model, built for more limited travel needs, consists of the same basic 30-ton turntable mounted on a 3-axle carrier that is propelled by the turntable engine, which may be either gasoline or diesel.

Circle letter (W) on reply card.

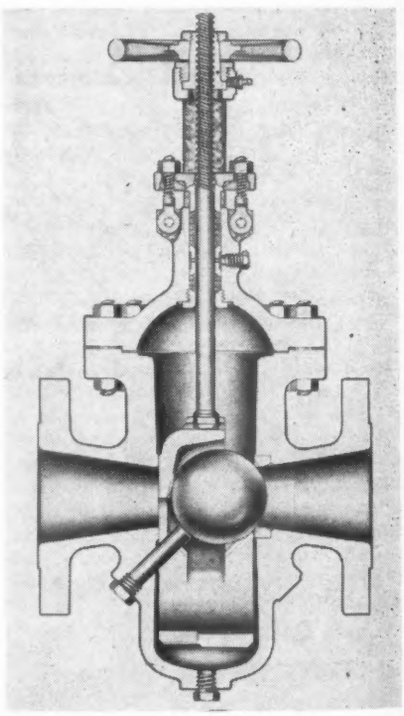
(X) INSULATION

Designed and manufactured for use where a highly efficient thermal and acoustical insulation is needed, with minimum weight requirements a consideration, Ultrafine is the latest addition to the growing insulation family of the Gustin-Bacon Manufacturing Company. It is lightweight, fine glass fiber insulation that is fire resistant, and that will not rot, mold, or decay. It is resilient and resists vibration.

Circle letter (X) on reply card.

(Y) BALL VALVES

A new line of valves, operating on a unique principle, has been announced by Crane Company. The disc in these



Crane-Paul valves, instead of being of conventional shape, is a ball. This ball is not attached directly to the stem, but rides in a cage attached to the stem by a tee-head slotted construction. In operation, the ball is moved to and from the center of flow and rolls into and out of the body seat.

Circle letter (Y) on reply card.

Trade Literature

Publication will be sent free.

(Z) SINGLE-ACTING VALVES

A new 6-page bulletin fully describing Golden-Anderson's cushioned single-acting non-return valve is now available from Golden-Anderson Valve Specialty Company. Three different yoke assemblies on the elbow, angle, and globe bodies are featured in detailed drawings, with a complete list of parts. The adaptability, testing, construction, installation, sequence of operation, servicing, and specifications are fully described.

Circle letter (Z) on reply card.

(AA) JET GUN

Welex Jet Services, Inc., has published a technical bulletin describing the four-way jet gun. The article summarized in the bulletin was written by W. H. Griffin, and contains much descriptive material and pictures. A temporary price list for this service is also included. The Welex jet gun will perforate four holes 90 deg apart at the same horizontal level.

Circle letter (AA) on reply card.

(AB) THREAD PROTECTORS

C. A. Gordon and Company, Inc., has made available a 2-page leaflet describing its new pipe thread protector. The protectors are said to assure protection to threads during handling, transportation, and storage, will not rust, no deburring of threads, no damaging metal to metal contact, and will not work loose in transit due to vibration. The Paulus protector is a non-metal protector that will neither harden nor soften, due to temperature extremes.

Circle letter (AB) on reply card.

(AC) ENGINEERING SERVICES

The services of a new organization specializing in the designing, engineering, and building of special equipment, coordinated process controls, and panelboards are described in a new four-page bulletin available from Equipment and Controls Engineers, Inc. Featured in this bulletin are the key men of this organization, along with a list of those industries where their services can best be utilized.

Circle letter (AC) on reply card.

(AD) HYDRAULIC ANCHOR

The Guiberson H1 hydraulic anchor is discussed in a 4-page, 2-color bulletin published by the Guiberson Corporation. The hydraulic anchor is recommended by the company as a positive means of holding the packer and tubing down while the well is pressured below the packer, as an acidizing or formation-fracture process.

Circle letter (AD) on reply card.

(AE) STEAM VALVE

Brown Valve Division of Vernon Tool Company, Ltd., has published a 4-page bulletin on the Brown steam throttle valve. The cast steel valves are available in 3-in. and 4-in. sizes for all makes and types of drilling engines. The non-rotating stem design combines a stainless steel stem with a rotating bonnet bushing of high-grade bearing bronze.

Circle letter (AE) on reply card.

(AF) INDUSTRIAL PUMPS

A new catalog, published by The Deming Company, Salem, Ohio, contains 96 pages of illustrated information about numerous types of industrial pumps manufactured by the company. Identified as "Industrial Catalog I-52," the contents include sectional and exterior views of the various types of units, together with selection tables and other data of interest to pump users.

Circle letter (AF) on reply card.

(AG) PRECISION TOOL

A new folder describing and announcing the Vernon Tool Company Flame Cutter is now available. The Flame-Cutter is a precision tool for reconditioning, salvaging, and re-working all types of new and used welding ells, tees, flanges, reducers, etc. Some features are: Steel base, unitized control panel, etc.

Circle letter (AG) on reply card.

(AH) PIPE LINE PIGS

A comprehensive 16-page bulletin showing how to select and use Williamson Type GP pipe line pigs . . . for natural gas — big inch pipe lines, has been published by T. D. Williamson, Inc. It includes detailed descriptions of the GP-1, GP-2, and GP-3 pigs along with a complete parts list of each pig.

Circle letter (AH) on reply card.

(AI) SPEED REDUCERS

Issuance of a new 35-page catalog on Pacific-Western right-angle speed reducers, spiral bevel and helical gear types, has been announced by Western Gear Works. The new catalog, designated as Bulletin 5203, has information to assist the customer in selecting the proper speed reducer for any job.

Circle letter (AI) on reply card.

(AJ) OIL HOSE

A new eight-page catalog on its oil hose has been published by The B. F. Goodrich Company, and is available on request. The catalog describes nine types of oil hose for use in refineries and distributing terminals, on oil tankers and barges, for loading and unloading oil cargoes, or other services where flexbile connections are necessary.

Circle letter (AJ) on reply card.

(AK) WIRE LINE SPOOLING

A new 82-page, fully illustrated handbook giving the full story of LeBus International Engineers, Ltd., grooving and wire line spooling is now off the press. So far as is known, this is the first handbook ever published covering the full and integrated story on the spooling of wire line. LeBus International Engineers, pioneers on the development of grooving and wire line spooling, with the full cooperation of all wire line and drilling rig manufacturers, have prepared this very important wire line spooling handbook.

Circle letter (AK) on reply card.

(AL) DIESEL ENGINE UNITS

A preventive maintenance log book, which makes it easy to record recommended service and maintenance operations on GM diesel oil field engine units, has been prepared by the Detroit Diesel Engine Division of General Motors. According to the division, properly timed maintenance procedures carried out as indicated in the book, will assist drilling contractors and drillers materially in reducing costs and getting maximum performance and longer life out of their power equipment.

Circle letter (AL) on reply card.

(AM) GAS ENGINES

Production of a highly efficient series of four-cycle spark-fired gas engines is announced by Nordberg Manufacturing Company. These engines, known as Types FSE-9 and FSE-13, are built with 9-in. and 13-in. bore sizes respectively in non-supercharged, supercharged, intercooled-supercharged and Supairthermal types covering a range of 265 to 4260 hp. Both the Nordberg FSE-9 and FSE-13 engines burn natural gas, butane, propane, manufactured gas, and sewage gas. Other gases of lower British thermal units content can also be used, but at reduced ratings.

Circle letter (AM) on reply card.

(AN) PRESSURE DIFFERENTIAL

Fischer and Porter Catalog 29 describes the new constant pressure differential regulator, and the new instrument air pressure regulator. The constant pressure differential regulator is a compact unit consisting of the air pressure regulator and a new phenolic body purgerator meter piped together on a bracket for wall mounting, or with a bezel that permits front or rear panel mounting. This unit is used to regulate purge flows of liquid or gas, for liquid level measurement or in dual arrangement for specific gravity measurement.

Circle letter (AN) on reply card.

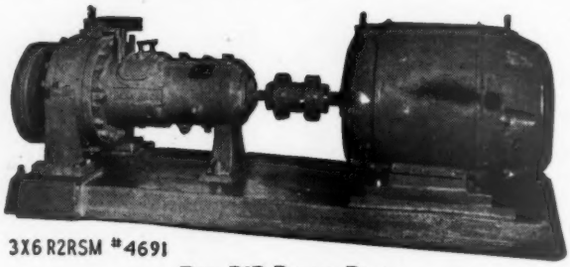
(AO) SPARK PLUGS

A pocket-size, 42-page booklet on spark plugs and how to cure their troubles has been published by Stitt Ignition Company. Well illustrated with cartoon characters, the booklet discusses spark plugs for oil field engines, how to care for the plugs, how to install them, heat range of plugs, and different types of plugs.

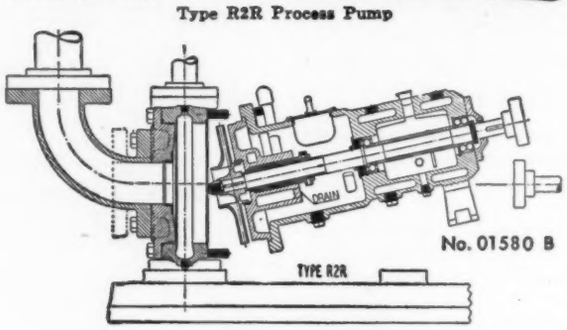
Circle letter (AO) on reply card.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

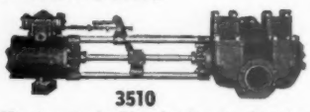
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

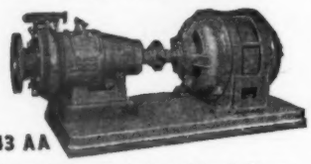
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL AND RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

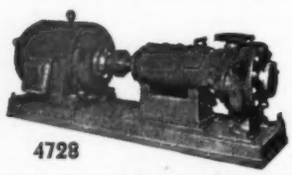


Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

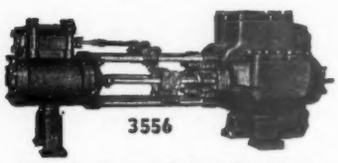


Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump



Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

New Equipment

(AP) HIGH VACUUM APPARATUS

An interesting and informative 56-page booklet on high vacuum apparatus, recently revised to include new type vacuum connectors, couplings, etc., has just been published by Central Scientific Company. It contains detailed information on planning the high vacuum system together with many valuable tables and charts. Included, also, is complete description of various types of high vacuum apparatus and accessories.

Circle letter (AP) on reply card.

(AQ) PACKAGING PRODUCTS

A new booklet on packaging of products has been published by The J. B. Beaird Company. It shows manufacturers how they can find bigger markets for such products as power units, process equipment, controls, etc., by having them completely packaged into composite products. The booklet describes Beaird's experience in developing packaged gas compressor plants, farm dehydration plants, etc.

Circle letter (AQ) on reply card.

(AR) DATA SHEET

A new quick reference data sheet covering a complete line of electrical measuring instruments is announced by Associated Research, Inc. This sheet lists models for insulation resistance, ground resistance, and high voltage testing plus other special purpose instruments.

Circle letter (AR) on reply card.

(AS) VENTURI NOZZLE

Builders-Providence, Inc., has just issued a new bulletin on the Saran-Lined Venturi nozzle. The Model NZSL is a flanged type differential producer without piezometer rings, designed for corrosive liquids and slurry service. This bulletin gives pertinent information of the uses of the Saran-Lined nozzle and shows a sectional view of the Model NZSL, and gives a list of corrosive liquids that can be metered with the nozzle.

Circle letter (AS) on reply card.

(AT) GENERAL PUMPS

Construction features of Allis-Chalmers supporting-adapter type, close-coupled general purpose pump in capacities to 2500 gpm at heads to 550 ft are described and shown in a new bulletin released by the company. Compact and requiring a minimum of space, the pump is available in a choice of packing or mechanical seal, and in a choice of materials.

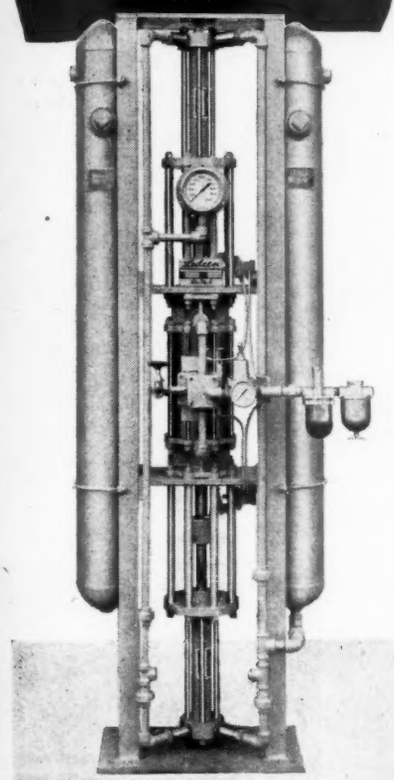
Circle letter (AT) on reply card.

(AU) VACUUM

"Vacuum — the Magic Hat of Industry" is the title of a 12-page magazine reprint available from Ingersoll-Rand Company. This article, reprinted from *Compressed Air Magazine*, is written in simple, non-technical language and describes the many varied uses of vacuum throughout industry. It also discusses the methods of making a vacuum. Included are two full-page charts on vacuum uses and manufacture.

Circle letter (AU) on reply card.

HIGH PRESSURE OIL
from
LOW PRESSURE AIR



Ledeen
PUMPS

Ledeen Heavy Duty Pumps and Power Units are built for operation of clamps, valve actuators, forming or drawing presses, safety installations, high pressure testing and other hydraulic circuits requiring adjustable pressure and volume and long pressure-holding cycles, without overheating the oil. Built as a complete package power unit, ready for easy installation, requiring connections only to incoming air line and outgoing hydraulic lines. Available in horizontal construction for minimum head room, and vertical construction for minimum floor space. Simple to install. Inexpensive to operate.

Write for Bulletin 4000

VALVES • CYLINDERS
AIR-HYDRAULIC PUMPS & BOOSTERS
VALVE ACTUATORS • AIR HOISTS

Ledeen Mfg. Co.
1608 San Pedro
Los Angeles 15, Calif.

New Equipment

(AV) HARD FACING

A newly revised 4-page two-color illustrated bulletin describing the Colmonoy Spraywelder and Sprayweld process is now available from Wall-Colmonoy Corporation. The bulletin describes and illustrates latest developments in Spraywelding equipment and techniques that enable powdered Colmonoy hard facing alloys to be fusion-bonded to metal parts by a three-step process to provide nonporous, wear, heat, erosion, and corrosion-resistant surfaces.

Circle letter (AV) on reply card.

(AW) CONTROL CIRCUITS

Minneapolis-Honeywell Regulator Company has published Bulletin 8504, which describes relay designed for use in electric control circuits to shut down the process when a predetermined control point has been reached. It contains data application and operational data, specifications, and installation information.

Circle letter (AW) on reply card.

(AX) VALVES

Shafer Valve Company, Inc., has a new 2-color, 8-page booklet describing its valves. It contains diagrams, pictures, and complete description of new plug valve operator and control that offers reliability, speed, and ease of installation. The control attached to the Shafer operator provides a simple means of governing the supply of high pressure gas from the main line or from an auxiliary air line to the Shafer operator.

Circle letter (AX) on reply card.

(AY) PUMPING UNITS

Vickers, Inc., has published a new bulletin describing its long stroke hydraulic oil well pumping units. Both engineering data and a complete description of design features and advantages for heavy duty pumping are given in detail in this bulletin, No. 52-51. The bulletin, done in 2 colors, is well illustrated with pictures, charts, and diagrams.

Circle letter (AY) on reply card.

(AZ) CONTROL CENTERS

A new 31-page application booklet on control centers is available from the Westinghouse Electric Corporation. Stressing the case for centralizing all controls of an entire system in one group of enclosures, this booklet discusses the characteristics of control centers that make for flexibility of application, ease of servicing, and safety of operating personnel.

Circle letter (AZ) on reply card.

(BA) GENERAL PRODUCTS

Globe Steel Tubes Company has just published a new general catalog. The catalog is well illustrated, with pictures, charts, and diagrams. The company reports that its stainless steel tubes will meet the most exacting conditions and may be used for heat resistance, cold resistance, and corrosion resistance. A complete analyses of Globe products is included.

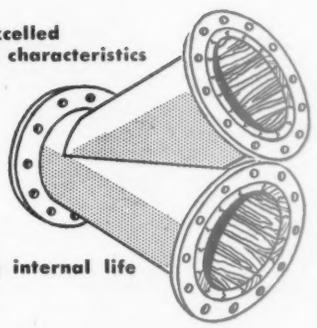
Circle letter (BA) on reply card.

5 reasons WHY

mpc WOOD-LINED STEEL PIPE IS IMPORTANT TO THE PETROLEUM INDUSTRY

1 Non-corroding

2 Unexcelled flow characteristics



3 Long internal life

4 Unexcelled cushioning capacity against pulsations, vibrations and other mechanical influences

5 Low cost

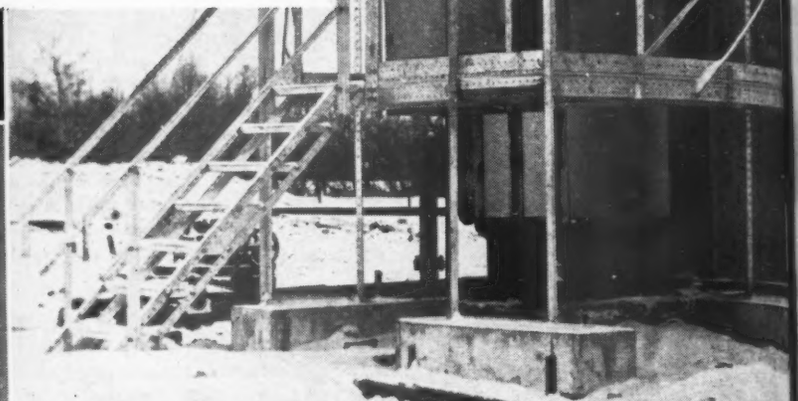
Combines the strength of steel with the durability of wood. Recommended for salt water lines, desalting service, dilute caustic soda and polysulfide transport, acid wastes, cooling tower service and oil gathering lines. Operating service up to 250 p.s.i. and 180°F. Higher pressure ratings for special service requirements. All pipe flanged and available in 10′ and 20′ standard lengths or custom fabricated to specifications. Diameters 4″ thru 48″. Easy to cut and re-flange. All flanges have standard ASME bolt circle.

Wood-lined fittings in standard and special designs for all diameters. For catalog and additional information, write Dept. PE.

mpc
MICHIGAN PIPE COMPANY
Bay City • Michigan
Manufacturers of Wood-Stave, Saran Rubber-Lined, Stainless Steel and Monel Piping

National

TANK ENGINEERS SOLVE CRUDE HEATING PROBLEMS IN LEDUC FIELD



SOUTH LEDUC—4′ x 27½′ "YCP" 15# National Treater

LEDUC—4 Hi-500 Bbl. National Bolted Steel Tanks

1 6′ x 20′ "YIWP" 15# National Treater

1 2C, 2½′ x 13′ 125# National Separator

1 NC, 2′ x 6′ 125# National Separator

Instead of expensive boiler installations, many Canadian operators are turning to National Treaters to maintain crude pour point under extreme weather conditions. Temperatures as low as 60° below zero, inadequate water supplies, frequent shut-downs, oil loss through steam heat evaporation were the difficulties that led National engineers to a practical and economical solution.

By re-designing piping hook-ups and circulation lines, by putting crude in at the bottom of the tanks and by installing a National Treater instead of a boiler, all difficulties of maintaining pour point have been eliminated. Crude is circulated from tanks through treaters. Unlike boilers, National Treaters require very little water.

They can be shut down for several days without draining without fear of freeze-up. If a longer shut-down is necessary, water can be drained quickly. Refilling to go back into operation can be done easily and at a minimum cost.

It's a National

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

1-2-53